THURSDAY, NOVEMBER 4, 1915.

SCIENCE AND NESCIENCE.

MUCH attention has been given recently in Parliament and the public Press to the subject of protective measures against Zeppelins and other hostile aircraft. The position of the matter suggests that we have here another instance of the result of neglect of scientific knowledge, and of the prevision which comes with it, in our national executive. For many years Germany has been perfecting the Zeppelin airship with the view of making it an effective weapon of war. Every failure of an airship during this period has been gleefully chronicled in our daily papers, but until Zeppelins appeared over Antwerp and rained down bombs upon the city, little serious attention was given to them by the lay Press. We should have supposed, however, that the executive officers of departments entrusted with the country's defence would be fully informed of the progress that was being made, and that practical provision would be made to meet the danger likely to arise.

It appears now that our confidence has been misplaced, and that only in recent months have scientific measures been instituted to protect the country from airship attack. It is not for us to suggest how such attacks may best be met, but we do think there might have been a more capable anticipation of them and adequate means devised to meet them. It is easy to conceive airships in the future having sufficient strength to withstand all ordinary weather, but for offensive operations of value they cannot avoid being in sight of the ground, and thus laying themselves open to attack. We trust, therefore, that the possibility of airships being able to survive the anti-aircraft gunnery of the immediate future is remote, provided that their range can be found.

We are not, however, concerned here with these technical matters so much as with the national characteristic of indifference to scientific plans of action, whether pertaining to operations during war or of industry in times of peace. So little attention is given to science in most schools and colleges that it is rare to find an administrative officer or leading writer or speaker able to make a clear distinction between it and magic. With a few exceptions, the men who control or influence the welfare of the nation have been trained in schools in which science and humanity are regarded as antithetic. We were reminded very definitely of this in the early days of the war, when German barbarisms were placed at the door of scientific education by many writers in the daily Press; and we were warned not to depart from the road of literary culture if we wished to maintain our national characteristics. Since then the need for science in connection with inventions and munitions of war has been seen, and scientific committees have been appointed for various national purposes; but their work cannot be used to the utmost until our executive officials also possess a knowledge of science.

The whole system by which men are selected for administrative posts, or other positions of influence, is archaic, and neglects the knowledge of scientific methods demanded by a modern State. It is time to understand that no man can now be considered to have received a liberal education unless he has some acquaintance with the principles and methods of science; and that works of Pasteur and Faraday should be as familiar to all as those of Victor Hugo and Tennyson. The training which ends in literary culture without science is just as incomplete as that which promotes scientific knowledge without the power of clear expression.

Judging from statements commonly made in newspapers—not only in daily papers, but also in weekly periodicals in which greater accuracy might reasonably be expected—few writers have any knowledge of natural objects and phenomena. It is scarcely too much to say that, omitting signed articles written by experts, few newspapers make any announcement relating to a scientific subject without committing a mistake. Either terms are wrongly used, or a matter of common knowledge among men of science is regarded as a remarkable discovery, or sensational claims are presented to the public as if they were established truths, though they await confirmation from the scientific world, and are mostly unworthy of serious consideration.

It may be too much to expect men of letters to possess an elementary knowledge of science, or to have any sympathy with scientific precision, but it is not unreasonable to ask for accuracy of description when they are dealing with natural facts or phenomena. They may reply that even Shakespeare was at fault in matters pertaining to natural history; but he, at any rate, reflected in his works the best knowledge of his time, which is more than can be said of most writers to-day. We are often told that men of science should cultivate the art of literary expression, but the stronger necessity for men of letters to have at least a nodding acquaintance with the out-

standing facts of natural knowledge is overlooked. A well-known writer has unkindly said, "The man of science appears to be the only man in the world who has something to say, and he is the only man who does not know how to say it." The retort invited by this remark is that the man of letters frequently has nothing to say, and he says it at great length. The first business of the man of science is to create new knowledge, and not necessarily to clothe his discoveries in a pleasing dress, though he may do so. The facts of science provide material upon which literary art may be exercised, but the two functions of exploration and fine expression are rarely found together.

The methods of accurate observation and cautious interpretation demanded of scientific investigators do not readily lend themselves to attractive description, and the results require more mental concentration to understand them than is usually demanded of a literary performance. A writer of romance can let his imagination have free play, but when natural occurrences enter into the story they should be presented accurately if the material is to be used rightly. Nothing is easier than to be deceived by appearances, or to accept an assertion without inquiring into its foundations. The scientific plan of asking for evidence, and of limiting statements to those for which good justification can be produced, is much more tiresome, yet it is the only way by which truth can be attained; and that, after all, is the highest aim.

Writers in the popular Press, and in technical papers also, frequently indulge in cheap sneers at what they call "scientific theory." In their minds the man of science lives in a world far removed from the realities of life, and knows little of material things or practical possibilities. Nothing could be more incorrect than this view. With the exception of pure mathematics and metaphysics, every branch of physical and natural science depends for its progress upon practical work in the laboratory or the field. No one appreciates the value of experimental work more than the man of science, and no one is more critical of scientific theory. Whenever a theory is put forward in scientific circles, it is always subjected to severe attack from people most competent to point out its weaknesses; and, in any case, it only survives until someone brings forward evidence which disproves it.

Whether the world recognises it or no, all its material advance has been achieved by men of science. In the arts of sculpture and architecture, in literature, in philosophy, the position gained by Greece two thousand years ago remains the standard of excellence for the moderns, whereas the last fifty years or so have seen more additions to natural knowledge than all the ages before them; and the result has been not only advance in material welfare and comfort, but also in intellectual outlook. The present era will not be remembered in future history for its art, its literature, or its drama, but for its science, by which it is placed pre-eminent above all others. Though this is undoubtedly the case, the public is still guided and taught chiefly by men who know little or nothing of scientific methods or modern learning. It is not surprising that under these conditions the nation has yet to learn how to derive the highest advantage from the great scientific forces at its disposal.

THE COMPLETE WORKS OF TYCHO BRAHE.

Tychonis Brahe Opera Omnia. Tomus II. Edidit I. L. E. Dreyer. Pp. 461. (Copenhagen: Nielsen and Lydiche, 1915.)

THE first volume of this sumptuous reprint of the complete works of Tycho Brahe was noticed in NATURE last April. There will be thirteen volumes in all, of which the second has now appeared, containing the first and second of the three parts of the *Progymnasmata*. This is a posthumous work, as although a large portion of it was printed at Hveen under Tycho's direction, it was not completed until 1602, the year after his death; Kepler saw it through the press, and added an appendix. It is a general treatise on astronomy, both observational and theoretical; it commences with a dedication to the Emperor Rudolph II., and the diploma that he granted to Tycho. A document follows that is of special interest to British readers; it is the "privilege" of copyright in Scotland for thirty years, granted to Tycho by James VI. on the occasion of his visit to Hveen in 1590, just after his marriage to Anne of Denmark. Two Latin epigrams that were sent to Tycho by James are also printed.

The motion of the sun is the first astronomical problem discussed. Tycho in the beginning followed his predecessors in assuming that the solar orbit round the earth is an eccentric circle, described with uniform motion. This assumption involves adopting an eccentricity of the orbit that is just twice the true value. Shortly before the close of his life, he and Kepler detected the error of this assumption; it was too late to alter the matter in the text, as the sheets had been struck off, but Kepler drew attention to this correction, and some similar ones, in the appendix which he added.

Tycho made a good determination of the length of the tropical year, his error being only 1 second. He also obtained a good value of the constant of precession, by comparison of his results with those of Hipparchus and Ptolemy; he was able to show that the large "trepidations" or fluctuations in this motion, that were previously believed to exist, were wholly illusory.

Tables of the sun are given in the volume, the data extending to the year 1800. The annual advance of the perigee is taken as 45″, the true value being 61″. A short table of astronomical refraction is given; Tycho was one of the first to investigate this correction; his value 34′ for the horizontal refraction agrees with modern authorities, but he gives 5″ instead of 57″ for the value at 45° altitude. The erroneous assumption of 3′ for the solar parallax vitiated the refractions that were based on solar observations. Tycho's instruments were capable of proving that the true value was much smaller, but it never occurred to him to suspect the accepted value.

The section on the moon is specially interesting, for Tycho added important facts to our knowledge of its motion. He was an independent discoverer of the "variation," even if we admit the doubtful claim of Abul Wefa to be the first discoverer; in any case his writings were unknown in Europe until long after Tycho's time. Tycho also discovered the important "annual equation," and drew attention to the "reduction" arising from the inclination of the moon's path to the ecliptic. The mean values for the parallax and semidiameter adopted by Tycho, 60′ 51″ and 17′ 0″ respectivelv, are both too great, and further from the truth than the values 58′ 25″ and 16′ 25″ previously adopted by Copernicus. The latter, however, adopted an eccentricity double the true value, and Tycho greatly improved this element. Lunar tables are given in the volume, and their use illustrated by calculations of the details of the eclipses of the sun and moon that occurred near the end of the year 1601.

The chapter on the determination of the coordinates of the fixed stars opens with an account of the methods previously employed for connecting their places with that of the sun. The moon had generally been employed as an intermediary, either when visible in daylight, or when eclipsed, it being obviously practicable to connect the longitude of the shadow on the moon with that of the sun. Tycho used Venus as an intermediary; he found it possible to observe it in daylight when at its greatest brilliancy; the fact of its parallax, semidiameter, and motion being much smaller than those of the moon were great advantages. His star observations are astonishingly good, considering that no optical aid was available in his day; for example, fifteen values of the right ascension of Alpha Arietis, made between 1582 and 1587, and reduced to the end of 1585, range from 26° 0′ 4″ to 26° 0′ 44″, the mean value being 26° 0′ 29″, only 19″ less than the value calculated from modern data. Such work compares favourably with some that was done after the invention of the telescope, and it must be remembered that Tycho was ignorant of the existence of nutation and aberration.

He selected Alpha Arietis as the "Lapis Angularis" of his celestial structure, its proximity to the vernal equinox rendering it convenient for this purpose. A short list of fundamental stars, mainly in the Zodiac, have their places determined with special care. Then is given a less accurate catalogue of the longitudes and latitudes of about 800 stars for the epoch 1600. This must have been a great boon to his contemporaries, as the existing star catalogues were very inaccurate. A hundred bright stars have their right ascension and declination given for 1600 and 1700.

The reprint follows the original closely in type and pagination, the illustrations being reproduced in facsimile. They include diagrams of the instruments, which claim the admiration of astronomers, as the source of the observations from which Kepler deduced the laws of planetary motion.

The work is enriched with some annotations by Dr. Dreyer, directing attention to slips and inaccuracies in Tycho's text, or giving further information on various matters of interest.

ANDREW C. D. CROMMELIN.

PLANT-BREEDING.

Plant-breeding. By Prof. L. H. Bailey. New edition, revised by Arthur W. Gilbert. Pp. xviii+474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 8*s.* 6*d.* net.

THE new edition of Prof. Bailey's text-book of plant-breeding contains a good deal of fresh matter. The work first appeared in the time when no order had been perceived in the phenomena of variation or heredity, and chapters by Dr. Gilbert are introduced dealing with the recent discoveries. These sections of the book are well done so far as they go, but though various parts have been rewritten, signs of irregular growth remain, as is, indeed, in such cases unavoidable.

In his preface Prof. Bailey expresses with some frankness a regret that with the new knowledge the old simplicity of ignorance has been troubled,

and strict criticism would therefore be scarcely in place.

The book still serves what was doubtless its first purpose—to excite curiosity regarding the nature and origin of plant varieties and to suggest the enormous possibilities which still lie before the plant breeder. Special reference might have been made, in this connection, to tropical products. Few, for example, have yet realised what incalculable additions to the world's wealth can yet be made by simple means. Rubber trees, for instance, vary at least 200 per cent. in yield, and it is with amazement that a plant-breeder learns that the planters are content to sow, without regard to breeding or quality, trees which are to last many years. To a less degree this is true of cocoanuts and many other objects of tropical agriculture. The chapter on the vast progress made in the teaching and investigation of plant-breeding in the United States gives evidence that this neglect will not long continue. The practical hints might well be amplified. Nothing is said, for example, of the method of removing pollen by a water-jet, though this device was, by the way, an American invention. More curious is the silence on the subject of self-sterility, a phenomenon which, whether as an obstacle or a help, plays so large a part in the daily experience of every plant-breeder.

The author's theoretical views are occasionally novel. In particular, the statement is made that individuality in plants is something quite distinct from what it is in animals. This proposition might with value be developed in an essay elucidating some of the essential phenomena of variation, but it is by no means a self-evident truth, to say no more. From the long list of periodicals dealing more or less with the subject, the *Zeitschrift für Induktive Vererbungsund Abstammungslehre*, though by far the most important continental journal, has by some accident been omitted.

THE BRITISH RAINFALL ORGANISATION.

British Rainfall, 1914: *on the Distribution of Rain in Space and Time over the British Isles during the year* 1914. By Dr. H. R. Mill and C. Salter. 54th annual volume. Pp. 448. (London: E. Stanford, Ltd., 1915.) Price 10s.

THE volume contains the records of about 5500 observers in Great Britain and Ireland, and there are various articles associated with rainfall. A paper on isomeric rainfall maps of the British Isles was contributed by the director of the British Rainfall Organisation to the Royal Meteorological Society in November, 1914, and the present volume contains a summary of the paper with the monthly and seasonal maps. A frontispiece in colour shows the relation of the rainfall in 1914 to the average of 1875–1909. The distribution of rainfall in time is dealt with in various ways from the ordinary daily records. For the occurrence of rain days, droughts, and rain spells over the British Isles one hundred stations have been selected, distributed uniformly over the country. The number of rain days are given in a tabular form for each month, and graphically for the average 1892–1911 and for the year 1914.

The year may be regarded as one of average rainfall frequency in all parts of the country, with generally fewer rain days in the summer and more in the winter than in a normal year. Absolute and partial droughts are discussed; the former is represented by a period of more than fourteen consecutive days, no one of which is a rain day, while a partial drought is a period of more than twenty-eight consecutive days, the mean rainfall of which does not exceed 0·01 in. per day. A rain-spell is practically the antithesis of an absolute drought, and is a period of more than fourteen consecutive days, every one of which is a rain day; the number of rain-spells in 1914 compared with the average was slightly deficient. Monthly, yearly, and seasonal rainfalls are given in a tabular form and graphically; for the British Isles as a whole the rainfall in 1914 was 7 per cent. more than the average.

The Meteorological Office having introduced a new system of units for the official records of British meteorology, the British Rainfall Organisation has fallen into line, and has adopted the use of the millimetre as the unit for measuring the depth of rain. The annual total rainfall for all the stations is given both in millimetres and inches, and this addition has involved the widening of the page of publication. The difficulty as to a change in the definition of a rain day consequent on the use of the metric units has been postponed to next year, and no alteration in this respect has been introduced in the present volume.

Notwithstanding many difficulties arising directly and indirectly from the war, the rainfall work has been carried out in all its details, although the exigencies of the times have caused some reduction of staff, and naturally the income has dropped. Greater stress is expected next year, and a hope is expressed that the rainfall records, so essential to the good of the country, will not suffer. An effort is being made to augment the voluntary funds by the aid of which the work is carried on, but public funds are not at present available, and the Treasury has decided that in the circumstances no action can be taken,

so that the organisation has to continue to depend on its own limited resources.

The results secured are a great gain to numerous corporations, water boards, and others. The work was initiated by the late Mr. G. J. Symons more than fifty years ago, and year by year the labours of the British Rainfall Organisation have increased in value, whilst the results have become of the highest scientific importance to the country.

NEW BOOKS ON CHEMISTRY.

(1) *Chemistry of Familiar Things.* By S. S. Sadtler. Pp. xiii+320. (Philadelphia and London: J. B. Lippincott Co., 1915.) Price 7*s.* 6*d.* net.

(2) *First Course in Chemistry.* By Prof. W. McPherson and Prof. W. E. Henderson. Pp. x+416. (Boston and London: Ginn and Co., 1915.) Price 5*s.* 6*d.*

(3) *Laboratory Exercises arranged to accompany "First Course in Chemistry."* By Prof. W. McPherson and Prof. W. E. Henderson. Pp. ix+128. (Boston and London: Ginn and Co., 1915.) Price 2*s.*

(4) *Identification of Common Carbon Compounds.* By J. N. Rakshit. Pp. iii+222. (Calcutta: The Collegian Office, 1915.)

(1) THE author has attempted an important, though difficult, task, that of interesting the unscientific person in the achievements of chemical science. He has applied himself to it with evident zest. As he truly says, "chemistry can furnish interesting subject-matter for general consideration." The chapters follow one another in a rough, natural sequence and cover a wide field. So far as we have read, there seems to be no attempt to teach or explain general principles, but rather to convey information, and this is done in a didactic manner, which admits of neither hesitation nor question. Theories and facts are poured out with equal assurance, and a note of interrogation is rarely sounded. This is not the least defect. The style is poor and not always clear; the definitions are obscure and often inaccurate, and the text abounds in incorrect scientific and historical statements. We have picked out a score of examples, but they would fill half a column, and it seems scarcely worth while to reproduce them. It is a misfortune that a book so handsomely bound, so nicely got up and well illustrated, and upon which, no doubt, the author has expended much labour, should contain such poor stuff.

(2) The theoretical and the accompanying practical volume (3) on elementary chemistry are intended for the beginner who does not intend to pursue the subject very far, but desires such information as an educated person might be expected and, if we were not tied to tradition, ought to possess.

From this point of view the book appears to fulfil exactly the author's object. In fact, it might be used with advantage as a beginner's text-book, whatever later course he intended to pursue.

There is no attempt here to be popular at the expense of accuracy. The authors have set before themselves the task of giving a clear and logical account of the outstanding facts and theories of the science in a simple, attractive, and at the same time soundly conscientious manner.

Like many of the elementary chemistry books produced in the States, it is profusely illustrated with excellent photographs. There is much to be said in favour of such illustrations. They relieve the sober monotony of the letterpress and, provided the relief does not produce a mere picture-book, no harm can be done. But there is always this danger, and in the present case it has not been entirely circumvented. Is any useful purpose served by depicting three workmen spraying an orchard with a lime-sulphur spray, or the process of loading a block of sulphur on to a railway truck? Why is there no diagram or photograph of a sulphuric acid plant, which would be so much more instructive? These are minor defects and are heavily counterbalanced by the excellence of the text.

(3) The accompanying laboratory course contains a series of simple experimental exercises, carefully arranged and well chosen, to illustrate the theoretical points. The student is being constantly pulled up and a question thrust upon him. If he is a conscientious student he will try to answer it and so accustom himself gradually to the process of interrogating himself, which is the only intelligent way of studying practical chemistry.

(4) This little volume contains a carefully compiled list of common organic compounds, with an account of their properties and characteristic reactions, as well as a number of useful tables. It is intended as a laboratory guide to the identification of organic compounds, and in so far should afford considerable assistance to the student. There is no attempt at a scheme of systematic analysis of the compounds to be identified, but apparently a good deal of reliance is placed upon the melting-points, a list of substances being tabulated at the end in order of increasing melting-point. Whether this method of identification by melting-point is useful either

as a practical method of identification or as an intellectual exercise is open to question; we are inclined to think that it is neither the one nor the other, and that the table should only be consulted when the group character of the compound has been definitely ascertained.

The fact that the book is written by a native of Bengal and printed by a Calcutta firm explains the occasional lapses in English, which is by no means to the discredit of either publisher or author; but it does not excuse the far too numerous mistakes in the spelling of chemical names. It is unfortunate that the volume has not been read in proof by someone conversant with the language.

J. B. C.

OUR BOOKSHELF.

The Callendar Steam Tables. By Prof. H. L. *Callendar.* Pp. 39. (London: Edward Arnold, 1915.) Price 3*s.* net.

IN his Royal Society paper in 1900 and in his article on Vaporisation in the "Encyclopædia Britannica" of 1902, Prof. Callendar showed the use of a simple empirical formula connecting the pressure, density, and temperature of steam. If his formula is correct, it is possible to tabulate all the properties of steam required in engineering calculations in such ways that the numbers are more consistent with one another than any hitherto published. Mollier, of Dresden, published tables and corresponding curves calculated by this method, and these were republished in England by Ewing in 1910. Messrs. Smith and Warren calculated and published tables which were discussed in NATURE of April 3, 1913. We then gave reasons for the suggestion that perhaps such experimental results as were available scarcely justified the use of the Callendar method, in spite of the fact that Prof. Callendar is undoubtedly the highest authority on this subject. He now says that these tables form part of a larger work entitled "Properties of Steam," in which the theory of steam and experimental methods of investigation are more fully discussed and illustrated.

For the present we may, perhaps, assume that, for moderate pressures and temperatures, these tables are more correct than any hitherto published, and if this is so their value to the steam engineer cannot be over-praised. They give pound Centigrade and also pound Fahrenheit units, with pressures in pounds per square inch, volumes in cubic feet per pound, as well as kilogram Centigrade units, with pressures in kilos per square cm. and volumes in cubic metres per kilo. Table II. is the most important; it gives volume, entropy, temperature, and total heat in terms of pressure. Tables IV., V., VI., and VII. give the total heat, volume, entropy, and Gibbs's potential of super-heated and super-saturated steam. The diagram which accompanies the tables has been arranged for interesting graphical calculation. From this description steam engineers will see that, in addition to what is due for his engine experiments in Montreal, they owe the author a second deep debt of gratitude. The gas and petrol engine engineers also owe him a large debt. We do not think that there is any case of an experimental physicist since Regnault's time doing even half as much service to engineering.

J. P.

The Star Pocket-book, or How to Find your Way at Night by the Stars. By R. Weatherhead. Second impression. Pp. 92. (London: Longmans, Green and Co., 1915.) Price 1*s.* net.

THIS little manual not only provides an easy means of becoming familiar with the chief constellations and individual stars, but also shows how this knowledge may be made practically useful in the determination of position and direction during night marches. The book contains several useful tables giving among other details the time of year when certain stars transit at midnight, the highest altitudes of stars in various latitudes, and pairs of bright stars which transit at the same time. These simul-transit pairs, when vertical, mark the meridian, and also serve as pointers to a celestial pole. The new issue of the book includes some additional notes on the use of the stars as direction and time finders; and it should be found particularly helpful to soldiers and scouts at the present time.

The Cambridge Pocket Diary, 1915–1916. Pp. xv+255. (Cambridge: At the University Press, 1915.) Price 1*s.* net.

READERS whose work is connected with schools and colleges will find the arrangement of this attractively produced pocket diary very convenient. Beginning in the middle of September, it enables one to start a new diary at the commencement of the academic year. The miscellaneous information provided is intended primarily for members of the University of Cambridge.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Manganese Ore Requirements of Germany.

IN a letter, under the above title, published in NATURE of October 14, Dr. Leigh Fermor dissents from the conclusion reached in my article of July 15 on munition metals that the enemy countries can produce sufficient manganese for their steel manufacture requirements without having recourse to imports, and gives it as his opinion that they are likely to be seriously hampered by a shortage of manganese ore as soon as their accumulated stocks have been used. His conclusions are as follows:—

"(*a*) That on the outbreak of war the Teutonic Powers had no great accumulated stocks of manganese ore, perhaps a maximum of 200,000 tons; (*b*) that, assuming war conditions necessitate a maintenance of the iron and steel industries of those two countries at

a peace standard, about 600,000 tons of ore a year must be obtained from fresh sources to replace imports in time of peace; (*c*) that, allowing that the Teutonic Powers might succeed in increasing their internal production by 100,000 tons, and obtain 50,000 tons of manganese ore from Turkey, if the Allied Fleets could prevent all manganese ore from outside from reaching Germany and Austria, these countries would be faced with a shortage of 250,000 tons of manganese ore in the first year of the war, and with a shortage of 450,000 tons per year afterwards, increased to 500,000 tons per annum once the Dardanelles are forced.

"The Germans will doubtless find means of dispensing with the use of manganese ore as much as possible, and they may devise methods of utilising the manganese silicate, rhodonite, of which they appear to possess a considerable quantity; but it seems inevitable that the shortage of manganese ore, once it is felt, will hamper seriously the German iron and steel industries."

Dr. Fermor's conclusions, if correct, would mean that the German production of iron and steel must have been seriously diminished in the first year of the war, and that this diminution will be very greatly accentuated in succeeding years. Before producing evidence on this point which will, I think, be found to be decisive as to the issue between Dr. Fermor and myself, I should like to explain the reasons for the conclusion with regard to manganese at which I arrived in my article of July 15.

That article dealt with ten munition metals, and it was not possible within its limits to give more than a concise survey of the evidence bearing on each particular metal. I may say, however, that the detailed evidence which is so clearly and ably presented by Dr. Fermor with regard to manganese was available to and was considered by me, and that, excluding for the moment his brief reference to manganiferous iron ore, if this were all the evidence which had to be taken into consideration, I should have drawn the same conclusion as he has done—*i.e.*, that the enemy countries, and in particular Germany, could not supply their manganese ore requirements from internal resources.[1] There is, however, another factor which appeared to me on examination to be not only important, but vital. Dr. Fermor has also considered it, but evidently dismissed it as unimportant when he writes:—"I must note that in making the above calculations I have excluded figures for manganiferous iron ores from both the German and the world's figures as confusing the issue." It is with this factor that I must deal, for I came to the conclusion that it was decisive.

Although Germany prior to the war was a large and regular importer of manganese ores, she was by no means insensible of the technical value of her own deposits of manganiferous iron ores as a source of supply of manganese for steel production. In support of this assertion, it will be sufficient if I quote the following sentence from an article by Dr. Scheffer, of Dortmund,[2] which, it will be observed, was published shortly before the outbreak of war:—"Die Mehrzahl der Arbeiten die sich mit Manganerzen und Deutschlands Versorgung mit diesem Rohstoff befasst, beschäftigen sich nur mit der Manganversorgung Deutschlands aus dem Ausland ohne dabei zu berücksichtigen dass zur Erzeugung einer Reihe manganhaltiger Roheisensorten auch Eisenerze mit einem entsprechend niedrigeren Mangangehalt verwendet werden können und dass diese manganhaltigen Eisenerze im Inlande in grossen Mengen gefördert werden."[3]

Germany's production of manganese and manganiferous iron ores for the years 1908–1911, taken from Scheffer's paper, is appended in the following table:—

—	1908 Metric	1909 Metric tons	1910 Metric tons	1911 Metric tons
(*a*) Manganese ores (above 30 per cent. Mn) ...	392	474	166	177
(*b*) Manganiferous brown iron ores (30–12 per cent. Mn)...	279,611	266,685	266,825	288,049
(*c*) Manganiferous brown iron ores (<12–2 per cent. Mn)..	2,274,702	2,393,479	2,634,451[4]	2,791,923

The main source of the home supply is the Siegerland.

The figures show that while the output of manganese ores is infinitesimal, there has been a large and almost steady output of the higher grade manganiferous iron ore, and a decided increase in the very large production of low-grade ore, the total output being in 1911 more than 3,000,000 tons. Calculation of the manganese tonnages of (*b*) and (*c*) gives the following figures for 1911:—

	Tons
(*b*) Mean value of 21 per cent. Mn gives ...	60,490
(*c*) Mean value of 6 per cent.[4] Mn gives ...	167,515
Total	228,005

Taking now the German steel production in 1913, the figures are as follows:—

	Tons
Total steel produced	=18,960,000[5]
Steel exported	= 4,300,000
Home consumption of steel ...	=14,660,000

Assuming an average manganese percentage of 0·75 in the finished steel, this will absorb

	Tons
	109,942
Amount available	=228,005
Excess	118,063

From this it is clear that the tonnage of manganese contained in the ore as mined is *more than double that required to be present in the finished steel.* The excess would be available for deoxidising the fluid steel if it could be applied in a suitable form. Even here, however, it would not all be lost, for in 1911 the German blast-furnaces smelted more than 662,000 tons of manganiferous slag from open-hearth and puddling furnaces. With these facts before me, I had to consider whether the German manganiferous iron ores could be made available for steel manufacture in

[1] I am much obliged to Dr. Fermor for his explanation of the figures of American production, which is perfectly correct, for the information he gives of the mineralogical composition of the Indian ores, and for pointing out my omission of the Brazilian manganese ores.

[2] *Stahl und Eisen*, July 23, 1914, pp. 1246–1254. Other articles are published in "Glückauf," 1913.

[3] In the above article ores containing more than 30 per cent. of manganese are regarded as "manganese ores," while those containing both iron and manganese, the latter being present to the extent of anything between 2 and 30 per cent., are regarded as manganiferous iron ores. They contain technical values both in iron and manganese. The mineralogical concept of manganese and manganiferous iron ores is different; but we are only concerned with the metallurgical use of the terms.

[4] This is rather less than the mean value, but the estimate is purposely made conservative.

[5] Dr. Fermor gives this as 19·29 million tons in his first table, but this is the total *iron* production.

place of the customary ferromanganese or silico-spiegel. It has to be borne in mind that whereas in peace time in any given case that particular process holds the field which happens to be the cheapest, this is not the dominating consideration in war. If a commodity is essential for war purposes, and if the raw materials are available, it must be produced, *whatever it costs*. This being so, it appeared to me that while considerable departures would have to be made from ordinary practice, there was no insuperable difficulty in the technical problem of smelting the manganiferous iron ores in such a way as to render them available for steel production. It would not be advisable at the present time to say what my reasons were for coming to this conclusion, but I think my view would be supported by steel metallurgists generally.

Germany, however, has another source of manganese, the mineral rhodonite, which corresponds when pure to $MnSiO_3$. From this can be produced various grades of manganese silicon alloys by reduction in the electric furnace, as the following analyses show [6]:—

	No. 1. Per cent.	No. 2. Per cent.	No. 3. Per cent.
Manganese	74·2	70·3	55·0
Silicon	24·1	24·6	24·1
Iron	0·77	3·8	19·0

These products have the advantage over ferro-manganese of being low in carbon, and yet possess a strong deoxidising power. Their use is specially advantageous in incorporating both manganese and silicon in steel. I was not able to obtain any figures showing the extent to which Germany was manufacturing these alloys before the war, but it appeared to me to be very probable—indeed, almost certain—that a considerable production, for which preparation would have been made, was to be expected in war time. Taking these facts into consideration, the conclusion appeared to me to be warranted that the German miners and metallurgists would, under the stimulus of necessity, be able to render their country independent of the import of manganese ores, and I therefore placed manganese in the category of metals that Germany would be able to produce from internal resources.

Dr. Fermor has come to the opposite conclusion. Much the same view was stated, though even more strongly, by a writer in the *Times* early in the spring of this year, who predicted that, owing to deficiencies in manganese supply, the German steel industry would collapse in June, 1915. Fortunately, the issue between Dr. Fermor and myself can be settled by what is, after all, the most satisfactory method, viz., the appeal to facts. I will give them briefly. The source of my information is the "Statistik des Vereins Deutscher Eisen und Stahl Industrieller," published in *Stahl und Eisen* (August 5 and September 23, 1915). There is, in my opinion, no reason for regarding the figures as incorrect. They are published in the official technical organ of the German iron and steel industry. They contain evidence of the setback caused to that industry by the outbreak of war, evidence which is supplemented in an article by Dr. Schrödter frankly admitting the difficulties with which it has had to contend,[7] and they show that those difficulties have been successfully surmounted.

Statistics of production of the various types of steel in each district are given, and may be consulted by those interested. For my purpose, however, it is sufficient to quote the monthly output of cast iron and steel from the outbreak of war for a whole year:—

Month	Cast iron Metric tons	Steel Metric tons
August, 1914	586,661	567,610
September	580,087	660,615
October	729,822	900,227
November	788,956	892,814
December	854,186	928,294
January, 1915	874,133	963,790
February	803,623	946,191
March	938,438	1,098,311
April	938,679	1,012,334
May	985,968	1,044,107
June	989,877	1,080,786
July	1,047,503	1,138,478

These figures tell their own tale, and require but little comment. Confining our attention to steel production, the output for August, 1914, the first month of the war, was only 36 per cent. of the average yield in peace time—very little more than one-third. It appears to have taken the Germans only two months to overcome their technical difficulties, as is evident from the October figures, which represent an enormous increase over those of August—rather more than 50 per cent. Apart from slight fluctuations, the figures thereafter show a steady increase, until those of the last month of the war are more than double those of the first month, and represent a rate of production rather above 72 per cent. of the peace rate. There are no signs here of an expiring industry; on the contrary, I venture to think that an unprejudiced examination of the figures shows us that it has been getting month by month into a stronger position. It may be urged that a drop of 28 per cent. represents a not unimportant shortage. But I must point out that this is calculated on the total production in peace time, when, as in 1913, 22·6 per cent. was exported. This condition no longer holds. Subtracting this amount, we obtain a difference of only 5·4 per cent. between the peace and war figures of production; in a few months this will have vanished if war requirements demand it. I estimate that before the end of this year Germany will be producing steel at the rate of between 14,000,000 and 15,000,000 tons per annum, and that that rate can be increased if necessary.

The foregoing is an achievement to which I, for one, cannot refrain from paying my tribute of admiration, even though I ventured to predict it. It is in the fullest sense of the phrase an important technical success for German metallurgists. How has it been done? Dr. Schrödter will not say. What he does say is:—"Die Erzeugung unserer jetzt auf heimische Rohstoffe angewiesenen Eisenindustrie ist so gross dass sie nicht nur alle Anforderungen von Landheer und Flotte erfüllt, sondern auch die notwendigen laufenden Mengen an Eisen für Friedenszwecke und darüber hinaus bis zu einem gewissen Grade den Bedarf für unsere benachbarten neutralen Länder zu liefern vermag. Diese erfreulicher Tatsache ist offenkundig. Wie wir uns in unseren Rohstoffen decken ist unser und unserer Metallurgen Geheimnis das wir der verbündeten Welt unserer Feinde preiszugeben natürlich keinen Anlass haben."

I think, however, there can be little doubt that the utilisation of the German manganiferous iron ores supplies the answer.

Austria has also surmounted her technical difficulties in steel production.[8] Her output is very much

[6] Bureau of Mines, U.S.A., Bulletin 77, pp. 145-46.

[7] "Die Eisen industrie im ersten Kriegs Jahr," pp. 798-800.

[8] *Stahl und Eisen*, 1914, pp. 818-19.

smaller than that of Germany, but is still by no means unimportant. The figures are as follows:—

	Tons
Production between August 1, 1913, and May 31, 1914	=819,000
Production between August 1, 1914, and May 31, 1915	=727,500
Difference	91,500

Of this drop of 91,500 tons, no fewer than 49,700 tons occurred in the first month of the war, and the following figures show that her present rate of production is greater than in the corresponding months of 1914:—

	1914 Metric tons	1915 Metric tons
January	78,300 ...	79,100
February	80,000 ...	84,500
March	107,800 ...	110,500
April	94,100 ...	99,000
May	95,500 ...	80,800

(The diminution in May, 1915, was caused by the opening of hostilities between Italy and Austria.) I have quoted the Austrian figures (which do not include Hungarian production) because in the article by Dr. Kestranek, of Vienna, from which they are taken, there is a direct reference to manganese and steel production. It is as follows:—"Die Stahlwerke Oesterreichs vermöchten die volle Höhe ihrer normalen Erzeugung zu erreichen und zu erhalten, trotz der Knappheit mancher für die Stahlerzeugung notwendige Stoffe. Man lernte rasch mit dem Verfugbaren hauszuhalten, für das Ersetzbares Ersatz zu finden, und alle im Lande vorhandenen bisher unbeachteten oder nicht voll ausgenutzten Hilfsquellen zu erschliessen. So wurde Beispielsweise die für die Stahlerzeugung heute als unentbehrlich angesehene Legierung des Ferromangans, zu deren Erzeugung man fast ausschiesslich auf die Verwendung der kaukasischen Manganerze angewiesen schien, sichergestellt durch die ökonomischen Verbrauch der noch vorhandenen grossen Vorräte an fremdländischen Manganerzen und durch Heranziehung der *im Inlande befindlichen Lägerstätten von solchen Erzen.*"

It is clear from this that the Austrians had accumulated pre-war stocks of manganese ore, and that they have succeeded in utilising their native manganiferous ores.

To sum up. Unless the evidence I have brought forward is untrustworthy—and I see no reason to doubt the figures of production, which bear ample witness to the setback both to the German and the Austrian iron and steel industries caused by the outbreak of war, which was followed by a remarkable recovery in the case of Germany (only two months later), and which has been well maintained, and indeed improved upon, during the succeeding months—then the conclusion appears to me to be fully warranted that Germany has succeeded in rendering herself independent of external supplies of manganese. According to Dr. Schrödter she is, in addition to supplying her own needs, exporting steel to her neutral neighbours.

Austria has been aided by her stocks of imported manganese ore, but has also been successful in utilising her own deposits.

So far from the figures of production showing a decline, which would certainly have set in by now if the shortage of manganiferous ore predicted by Dr. Fermor were correct, they bear witness to a remarkable degree of vitality and expansion in German steel production.

I wish to acknowledge my great indebtedness to Mr. G. C. Lloyd, the secretary of the Iron and Steel Institute, for the help he has given me in obtaining the figures of German and Austrian steel production that I have quoted.

H. C. H. CARPENTER.
Royal School of Mines, South Kensington, S.W.,
October 23.

The Government Scheme for the Organisation and Development of Scientific and Industrial Research.

THE proposal to establish a permanent State-aided organisation for the promotion of scientific research, with a view to its applications to trade and industry, is a most hopeful sign of the times, and will be welcomed in principle by scientific workers generally. But, inasmuch as any such scheme necessarily implies a certain amount of State control and direction of scientific research, and, ultimately also, of the large body of scientific workers who will be brought within its ambit, there are certain important matters to be considered and settled in principle at the outset, if the scheme is to be as fruitful and successful as it ought to be. I venture, therefore, in the spirit of a friendly critic and well-wisher to the scheme, to submit to your readers the following paragraphs embodying some of the points which seem to me to need very careful consideration, in order that the freedom and interests of individual scientific workers shall be sufficiently safeguarded and conserved.

(1) In my opinion what is most needful in this country for the development of scientific research in relation to industry is a central fund for the subsidising of a *limited* number of important lines of investigation, initiated and carried out by scientific workers and technologists of repute, who are, or have been, sufficiently in touch with practical affairs as to have acquired at first-hand a real knowledge of industrial conditions and of the economic factors which will necessarily come into play in connection with any new development. Such proposals might be initiated either by individuals so qualified, or by any group or association of such individuals, and such persons should have a strong (if not a majority) representation upon any Advisory Council or Committee appointed either to select or recommend suitable subjects for investigation, or to advise in connection with the prosecution of any investigation so selected.

(2) The selection of a particular line of research should be governed by three considerations mainly:—

(*a*) Its importance and practicability as directly bearing either upon the development or revival of national industries, and particularly of those which, although producing essential commodities (*e.g.* synthetic dyes or optical glass), have through past neglect become localised abroad, or which may conceivably be threatened in the near future, or upon questions pertaining to the future better utilisation of national resources of raw materials (*e.g.* coal and its by-products).

(*b*) The probability of there being a successful issue of the investigation within a reasonable time.

(*c*) The fact that its inauguration and continuous successful prosecution would involve expenditure beyond the financial resources either of an individual investigator (even though he may be aided by grants from the existing research funds of scientific and technical societies), or of the institution in, or in connection with, which he may be working.

(3) Broadly speaking, there are three distinct classes of investigation which would come within the above category, namely:—

(*a*) Investigations with the object of establishing new or more accurate scientific data, or methods, involved in the design of industrial appliances or plant, or in the daily scientific control and supervision of important manufacturing processes.

(*b*) Investigations with the object of effecting some modifications in the details of an existing process whereby it shall become technically and commercially more efficient.

(*c*) Investigations with the object of converting a scientific discovery (or results which may be predicated from research in pure science) into a useful scientific invention.

(4) Whilst all the above three classes of research are, or should be, essential features in any organised scheme for the benefit of trade and industry, the third class is undoubtedly, not only the most important of all, but also the one which presents the greatest executive difficulties in procedure, and unless at the outset these difficulties are both clearly recognised and equitably met, the complete success of the scheme will be seriously jeopardised.

(5) It ought to be recognised in principle that an individual scientific investigator who may seek or obtain assistance from the central national research fund should be accorded the fullest credit and protection for the ideas which he may disclose, as also direct personal access (without having to invoke the aid or interest of some intermediary person or association) to the Advisory Council or Committee (or persons representing them) administering the fund. Furthermore, if the ideas or discoveries disclosed by him are deemed important and worthy of support, as likely to result in a useful invention, not only should the further investigation of the matter be entrusted to his unhampered direction, but also, in the event of such further investigation under his direction ultimately resulting in a useful invention, his rights and interests in the commercial results of such invention should be equitably provided for and ensured.

To the objection which may be made that the acceptance by a scientific worker of assistance from a public fund for the development of his ideas or discoveries implies forfeiture on his part of any pecuniary advantage which would otherwise accrue to him, it may be replied that a scientific worker ought not to be put into a worse position in regard to the development of his discoveries, merely because he is financially assisted by the State, than he would have been had he been financed privately. It is a just and necessary principle in the development of inventions, no matter whether such development is financed by the State or by some private person or syndicate, that the inventor *qua* inventor is as much entitled in equity to a reasonable interest in the commercial results of his ideas as is the financial power that he may invoke, and unless such principle is conceded at the outset in connection with the Government scheme, it will never attract, or be invoked by, the scientific inventor for the development of his ideas. In short, invention and discovery, being essentially "individualistic" products, cannot flourish or be fully developed on a "socialistic" basis; and in every State-aided scheme there lurks the socialistic danger.

(6) If the above principle be conceded, there are doubtless formidable difficulties in carrying it out. Thus, for instance, it will be necessary to provide that the communication of an idea or discovery of an individual or group of individual scientific workers to an Advisory Board must not merely be *confidential*, but shall also confer the same sort of *provisional protection* which the lodging of a provisional specification at the Patent Office now confers. In the second place, should the further State-aided investigation of the matter result in a useful invention, not only ought the resources of the British Patent Office to be placed freely at the disposal of the inventor for the adequate protection of his invention, but also steps would have to be taken to ensure the same protection in all important foreign countries. For unless this were done, foreign manufacturers and countries would reap the reward of British scientific invention financed by the British taxpayer, without having to pay so much as a single halfpenny by way of royalties to the British people, and Great Britain would for ever sacrifice a most fruitful source of "invisible exports" in the shape of "British inventions."

Moreover, it might easily happen that an idea or invention originating in Britain, under a Government scheme without due safeguards, might be freely imported into Germany, and through German sources be patented in other countries for the benefit of Germany; such things have happened in the past under the existing patent laws, and will happen all the more in future, if the new scheme does not fully protect British scientific inventions. There thus lurks in the new scheme the serious danger of its proving an instrument and organisation whereby British brains and capital will be exploited largely for the benefit of the foreigner, and whilst such danger may perhaps be minimised by wise foresight, it is inherent in the scheme, and it is difficult to see how it can be entirely eliminated.

(7) The foregoing considerations do not, of course, apply to the first of the three classes of investigations cited in section 3 hereof, but unless they are frankly recognised and fully met at the outset, the utility of the scheme in regard to the important third class of investigation will be nullified.

The above suggestions are offered as an individual expression of opinion, which is the outcome of the writer's experience in connection with the development of his own inventions, in the hope that the final scheme will be so framed and safeguarded, in the common interests both of scientific invention and of the British public, that it may be of the utmost benefit to all concerned.

WILLIAM A. BONE.
Imperial College of Science and Technology,
London, November 2.

Science in National Affairs.

WHILE the leading article in NATURE of October 21 under the above title must meet with general approval on the part of men of science, there are one or two remarks to which I feel it my duty to direct attention in the interest of science at the present time, so far as it appears to me.

The "Scheme for the Organisation and Development of Scientific and Industrial Research," as issued in a White Paper by the Board of Education, should be carefully considered by us all. I may say that there is very good reason to believe that the gentlemen named in the article in NATURE, Mr. Arthur Henderson, Sir A. Selby-Bigge, and Dr. H. F. Heath, although their chief interests may be in "other fields than those of science," are nevertheless sincerely desirous of improvement in the position of scientific research in this country. If this is so, it is surely our duty, as well as interest, as men of science, to assist so far as we possibly can in what is undoubtedly a new opportunity. There is no doubt that the administrative chairman, Sir Wm. M'Cormick, will gladly welcome suggestions made with the intention of helping the scheme.

I would point out that the Advisory Council, which has the control of the way in which money is to be spent, consists entirely, with the exception of the chairman above named, of well-known and honoured men of science. It may probably be found necessary to place on this Council representatives of biological

science, but this is a detail, and could be done at a later date.

Whatever may be our views as to a democratic constitution, it must be remembered that it exists, and nothing but obstruction is likely to result from throwing stones at it. It is to be feared that what feeling of opposition to science is present in the democratic mind is largely due to the arrogance apt to be shown by men of science. Skill and success in a particular branch of science alone do not warrant the demand that their possessor shall be regarded as capable of expressing opinions of value on any and all questions of public importance. The same may be said, of course, of any branch of learning. But it can scarcely be held that men of science, as such, have hitherto shown an especially great capacity for business or administrative ability; perhaps it may be because opportunity has been wanting.

We must also confess that ignorance of, or want of interest in, branches of knowledge outside their own domain is not exclusively confined to men of a literary or legal training. At the same time, it may, I think, be reasonably asserted that a wide outlook is more common amongst men of science than amongst other members of the community.

May I suggest that a more conciliatory attitude than that too often assumed with respect to what seem to be well-meant efforts on the part of Government Departments would be more to our interest and for the benefit of the nation? There is, no doubt, a very great deal yet to be done in connection with the position of science in the State. But we may do much in assisting those who are inclined to look with favour on our desires and demands, although it may be that too many of the positions of authority are filled by men lacking in appreciation of the meaning and aims of science. We have an opportunity of showing our value to the nation, and, if we use it well, greater duties and responsibilities will follow.

W. M. BAYLISS.

University College, London, October 23.

[WE do not doubt for a moment that the gentlemen mentioned by Prof. Bayliss take a sympathetic interest in the promotion of scientific research, but this can scarcely be regarded as specially enabling them to administer a scheme to promote the co-ordination of science and industry. What we particularly object to is the assumption, made in all Government offices, that men without scientific knowledge are alone capable of controlling scientific departments and committees. The executive officers of the Committee and Advisory Council on Scientific and Industrial Research represent only one illustration of a principle for which there is no substantial basis. Prof. Bayliss seems disposed to concede this principle: we are not. He suggests that men of science do not possess much business or administrative capacity: we do not accept this generalisation; and we hold that they could scarcely be less effective and less enterprising than administrators trained in unscientific schools. No one supposes that skill and success in science give authority to opinions expressed on other subjects, but neither does work in literary and legal fields create ability to deal with the practical problems of science and technology. Science has too long been content to occupy a subordinate position in the national executive; and the main object of our article was to assert its claims to a higher place.—ED. NATURE.]

A New X-Ray Technique.

THE remarkable therapeutic action of radiations with a range of wave-length from $3{\cdot}8\times10^{-5}$ cm. to $0{\cdot}99\times10^{-9}$ cm. is now generally known and recognised by the medical profession. Between the limits $\lambda=1{\cdot}72\times10^{-9}$ cm., the shortest wave emitted by a Coolidge tube, and $\lambda=0{\cdot}99\times10^{-9}$ cm., the length of the waves of gamma rays from radium C, there is a gap which has so far defied all attempts at bridging.

Meanwhile, physico-physiological laboratories have their hands full with many problems concerning the action of the numerous radiations already available. Research work in this direction can only progress slowly; far more slowly, in fact, than investigations undertaken in perhaps any other branch of physics. But the prospect of final success, and in any case the task of alleviating sickness and pain, is so compelling that he who attacks this problem in the true spirit of science is unconscious of any sacrifice.

Now the various strong inducements presented to the physician by this new method of treatment have led to the hasty accumulation of a large number of facts and a mass of data which serve at the present time as the basis of modern X-ray technique. In the absence so far of any wide generalisation emanating from laboratory work, this necessary knowledge has been largely acquired by the elementary process of trial and error.

I wish, however, to refer here only to that part of the subject which relates to the treatment of deeply-seated tumours and to point out that so astonishing, both as regards action and inaction, are many of the results of treatment by this pleasant and painless means that it is very desirable to pursue the matter as systematically as possible. From the outset, the physician has met with the difficulty of administering a large dose of radiation to an internal region of the body without endangering the more superficial tissues. It has hitherto been usual, therefore, to make comparatively short exposures, taking care at the same time that the intervals between them be not too brief. In order to obviate this drawback the method of "crossfire" has been largely developed on the Continent, the patient being mapped out into several definite areas and the exposures made through several "ports of entry," with the rays always pointing towards the seat of disease.

It occurred, however, to the writer some months ago that by a suitable means of rotating a single X-ray tube and screening off with lead the rays from it, except a comparatively small pencil of them, it would be possible to bring to bear upon a deeply-seated region in the body a far greater amount of radiant energy in a given time than existed at the skin surface during treatment. Intensity of radiation is defined as the energy falling upon one square centimetre of receiving surface, and it is clear that if a conical beam of X-rays could be sent towards a diseased region so that the apex of the cone rested upon the neoplasm, the intensity of radiation there would be far greater than at the skin surface, where the area traversed by the rays is larger. But this would involve a source of rays consisting of a beam of large cross-section and the ability to concentrate it to a focus, the former condition being difficult to obtain and the latter impossible.

Nevertheless, since time enters into the question in the case of therapeutic action it is possible to approximate to the above conditions by the simple device of attaching the X-ray bulb to the circumference of a slowly revolving wheel of about 18 in. diameter, and with its axis pointing towards the diseased region. The screen is arranged to give a slanting beam that makes a convenient angle with the axis of rotation. Thus a hollow cone is swept out by the revolving pencil of rays, and it becomes possible to give a dose of radiation to a deeply-seated tumour ten or more times as great as that received by the skin. In this

way the exposure can therefore be safely made at least ten times longer than is usually possible by the ordinary method in general use and without damaging the superficial tissues.

It is to be noticed that the chief advantage of this plan lies in the fact that whereas at the apex of the cone swept out by the revolving beam the radiation is operative during the whole exposure, at the skin surface the pencil of rays only impinges upon a small area at any moment, always passing slowly on as the tube revolves so as to irradiate a large ring, section by section, of perhaps one inch in width.

Some rough experiments already made by the writer with a crude form of tube frame revolved by hand have given promising results. In spite of the fact that the source of radiation in a focus tube is practically a point, all rays being therefore divergent and their intensity falling off inversely as the square of the distance; in spite, too, of the absorption of some of the beam's energy as it traverses the tissues, it was found that the time-intensity factor could be made in this way considerably larger at the seat of the disease than at the skin surface.

The method is already being given a practical trial at the Cancer Hospital, London, and may prove later to be applicable also in treatment by radium.

C. E. S. PHILLIPS.

Castle House, Shooters Hill, Woolwich, S.E.

Australian Photographs.

READERS of NATURE, and especially members of the British Association, may be interested to know that I have received to-day (October 25), too late for incorporation in the "Overseas Camera in Australia," now being distributed to subscribers on behalf of the funds of the British Red Cross Society and Order of St. John, a remarkably fine series (300 or more) of photographs of features of general and scientific interest of New South Wales, presented by the Premier of this State through Mr. J. H. Maiden, the director of the Botanic Gardens, Sydney, and taken by the Government printer. The photographs are of interest to botanists, zoologists, foresters, agriculturists, geologists, miners, and astronomers. I shall be glad to supply lists or further particulars to anyone interested.

13 Palmerston Park, Dublin. T. JOHNSON.

Explosive Bombs.

I HAVE been studying the effects of explosive bombs on windows, and should greatly appreciate any information as to the effect of the explosions on the diagrams of recording barometers: (*a*) in the open air, (*b*) in rooms. ALFRED S. E. ACKERMANN.

25 Victoria Street, Westminster,
London, S.W., October 28.

TRENCH "FROST-BITE."

DURING the winter campaign of 1914–15 a number of soldiers fighting in the trenches in Flanders became disabled from the effects of cold and wet on their feet. The condition is to be distinguished from true frost-bite, in which severe cold causes necrosis or death of the tissues; but though this may occur, it is infrequent in trench frost-bite, the characteristic symptoms of which are swelling, pain, and disturbance of sensation in the part affected. For this reason Delépine[1] suggests the name "frigorism" or "frigidism" for this condition, corresponding with "froidure," used by several French writers.

Three factors seem to be concerned in the causation of trench frost-bite, viz., cold, wet, and interference with the circulation in the leg and foot by tight puttees and boots. Lorrain-Smith, Ritchie, and Dawson[2] have investigated experimentally the pathology of the condition. The microscopic examination of the tissues showed that the chief effect of the cold is exerted on the blood-vessels, which become dilated and contain a certain amount of fibrin deposit, their internal endothelial lining becomes swollen, and the muscle fibres of the middle coat are vacuolated. The axis-cylinders of the nerves of the part become swollen and œdematous, and some slight changes in the fibres of the voluntary muscles may be observed.

Delépine (*loc. cit.*) has conducted a number of experiments on the causation and prevention of trench frost-bite. He finds that exposure to cold, dry *air* caused a lowering of temperature of the part, which, however, is slight and not progressive, but immersion in a limited amount of cold *water* caused a rapid and considerable, though not permanent, lowering of temperature, and, provided the bulk of water does not exceed twice that of the part immersed, is not detrimental. When, however, the amount of water at a temperature below that of the skin is unlimited, or if the water is limited in amount but contains ice, the lowering of temperature of the part is rapid, considerable, and progressive, and invariably results in *local frigorism*, and motion of the external water accelerates loss of heat by preventing the formation of a comparatively warm surface layer. The presence of a thick woollen covering retards loss of heat, even when saturated with water, owing to the warming of the comparatively still layer of water retained within the meshes of the fabric. It was found that a very thin layer of moderately dry air between the skin and the external cold water or ice suffices to reduce the loss of heat to an extent which is compensated by the heat brought to the part by the circulating blood. Such an air layer over the part can be secured by the use of a thin waterproof covering in combination with a woollen covering.

After many trials, Dr. Delépine has succeeded in preparing very thin and soft oil-silk, which can be made into absolutely waterproof bags for covering any part of the body by means of apposition seams. They are light, inexpensive, and wear well, should be worn over an inner woollen sock, and be protected by an outside sock. With such a combination it is possible for the men to use the boots they have at present, provided they are two sizes larger than ordinarily worn. The oil-silk bags should extend up to the knee, and could probably be made for less than 3*s.* a pair. The importance of having nothing tight round the leg is obvious—the circulation in the part should be as free as possible, so that the circulating blood may maintain the warmth of the limb.

R. T. HEWLETT.

[1] "On the Prevention of 'Frost-Bite' and other Effects of Cold." *Journ. Roy. Army Med. Corps*, May, 1915.

[2] *Lancet*, September 11, 1915, p. 595.

BRITISH BIRD BOOKS.

(1) TWELVE chapters on birds by the Hon. Mrs. Murray, which have for the most part already appeared in various magazines and journals, are now reprinted, and, under the title of "A Birdlover's Year," made to synchronise with the month of the year, although in some cases the subjects dealt with have nothing in particular to do with the month under the name of which we find them.

Grasshopper warbler. From "A Birdlover's Year."

In January winter birds are discussed appropriately in some half-dozen pages. In February we as naturally consider the song thrush and its travels, chiefly in the light of Mr. W. Eagle Clarke's "Studies in Bird Migration." April suggests the return of the birds, and May the birds as builders. There are pleasant summer sketches of a "Yellow-Hammer Lane" and bird-life of the hills; and autumnal ones on October bird-life and birds as travellers. The rest deal with ocean wanderers, Tayside summer visitors, gulls and terns, and hawks and falcons. The Rev. H. N. Bonar contributes thirteen pleasing photographs of bird-life, among which we may especially notice a lapwing preparing to brood her eggs, an excellent one of a common sandpiper on her nest, and another showing that shy and elusive bird, the grasshopper warbler, going on to hers. This must have been difficult to get, and the photographer is to be congratulated. The two last are here reproduced by permission of the publishers.

Sandpiper on its nest. From "A Birdlover's Year."

(2) Mr. Thorburn's beautiful bird-studies are so well known and greatly admired that the announcement of a new work on British birds by him, to be illustrated with coloured figures, was received with considerable interest and expectation by all those of the public who concern themselves with our native avifauna. Probably it was felt by many people that if an excuse could be put forward for the issue of yet another work on the subject, that excuse might well be found in the Thorburn illustrations. The first volume of the book is now in our hands, and we can see how far our anticipations have been fulfilled. We do not think that any disappointment will be expressed (but rather the contrary), although it is probable that the original studies were even more beautiful than the plates now before us. For the latter are apparently produced by some form of the three-colour process; and it is unfortunate that in this process one of the colours sometimes obtains undue prominence, and produces shades which were not intended to appear, and doubtless

[1] (1) "A Birdlover's Year." By G. G. Murray. Pp. viii+149. (London: Eveleigh Nash, 1915.) Price 3s. 6d. net.
(2) "British Birds." Written and Illustrated by A. Thorburn. 4 vols. Vol. i., pp. 148+19 plates. (London: Longmans, Green, and Co., 1915.) Price, 4 vols., 6l. 6s. net.

did not appear in the original drawing. But these slight and unavoidable lapses are in this case so few and so little noticeable that they do not detract in any appreciable degree from the beauty and accuracy of this charming series of pictures of our birds.

A characteristic of this work is that it aims at including every species of bird which has occurred in these islands. Other earlier works have done the same. But accidental wanderers, "new to the British list," occur here from time to time so frequently that a book soon gets out of date in this respect. Indeed, these additions to the British list have poured in at such an astonishing rate of late years, especially from one district in England, that Mr. Thorburn has had the opportunity of figuring, for the first time, as British, quite a large number of birds which have, many of them unexpectedly, appeared on our list. To have not merely a figure, but a beautiful coloured figure of all these will be most acceptable, especially to those who attach any great importance to these recent additions or many of them. At all events, we are all glad to know what they look like without referring to books perhaps not very accessible. Among those birds now painted for the first time as British we may mention the dusky thrush, black and pied wheatears, thrush nightingale, subalpine and Sardinian warblers, masked shrike, and collared flycatcher; and there are a good many others also. A number of birds are figured on each plate, and this, giving as it does an opportunity of comparing at a glance two or more nearly allied species, will be a great advantage to the beginner in ornithology and to those not far advanced in the study of British birds. And it is to these, we suppose, that the book will chiefly appeal, although there will be many past-masters in the art who will not be able to resist the desire to possess such a beautiful memorial of their favourites.

Some appropriate plants, flowers, and branches, introduced and skilfully blended in the plates, are instructive as to birds' habits, and greatly add to their beauty and effect. We may mention, for instance, the gorse blossom about the Dartford warbler and the stonechat, the rosemary on which the rufous warbler is perched, and the gentian by the side of the Alpine accentor; while a yellow crocus near the cock blackbird matches his orange bill. Most of the birds were drawn from life, and are the result of many years of studies of birds from the life with this object in view. To this we owe the remarkable success the author has had in catching the characteristic attitudes of the birds depicted. When it was not possible to obtain living birds for the drawings, the author has filled up the gaps from the best preserved specimens he could procure. Of the letterpress in this work it is not necessary to say much, because, as the author points out, being more familiar with the brush than with the pen, it was his first intention that the book should be simply a sketch-book of British birds practically without letterpress. But as the work proceeded he was induced to write a short description of the various species. Thus we have a condensed account of the distribution, nest and eggs, food, song, and general habits of each species. This letterpress is admittedly and of necessity largely a compilation, but the author has inserted, in addition to what has already appeared in print, such notes as he has been able to add from his own and his friends' observations.

So far as we can see from the present volume, the author may be congratulated on having produced the most accurate series of coloured figures of British birds (as such), as well as quite the most beautiful book on the subject, which has yet appeared. The publishers are also to be congratulated on the form in which it is issued. It is beautifully printed on really good paper, and the plain red linen-cloth cover with a gold line is just what we should desire. O. V. A.

SIR ANDREW NOBLE, BT., K.C.B., F.R.S.

SIR ANDREW NOBLE, the chairman and managing director of Sir W. G. Armstrong, Whitworth and Co., died on October 22 at his residence in Argyllshire. He was a great man of business, but what was more important to his country, a great scientific artilleryman. The story of his scientific work is, in fact, the history of the development of artillery in all its branches from the time of the Crimean War to the present date.

When Noble entered the Royal Artillery in 1849, after passing through the Edinburgh Academy and the Royal Military Academy, Woolwich, line-of-battle ships were all sailing vessels; the heaviest gun weighed 95 cwt., and fired a projectile of 68 lb.; rifled guns did not exist, and little or nothing was known of the principles of internal ballistics. This state of affairs was the opportunity for a clever, energetic officer with distinct scientific ability, and Noble was not long in forcing his way to the front. After serving for a short time with Sir Edward Sabine on the magnetic survey at the Cape, he became, in 1857, secretary of the Royal Artillery Institution, and wrote his first important paper, "On the Application of the Theory of Probabilities to Artillery Practice." He had in the meantime been appointed secretary to the Committee on Rifled Cannon, and it became necessary to ascertain the relative precision of fire of the various guns which came before the Committee for report. This he accomplished by calculating for each gun the area within which it was an even chance that any one shot would strike. He introduced the phrase "probable rectangle," which has been one of the commonplaces of artillery science ever since. The method adopted was naturally that of "least squares," but in applying this celebrated theory he showed much scientific intuition. He calculated separately the probable errors in range and deflection, and thence deduced the dimensions of the rectangle.

In 1859 Noble became secretary of the Com-

mittee on Plates and Guns, received the appointment of Assistant Inspector of Artillery, and entered the proof department of Woolwich Arsenal. Almost immediately after this he was made an associate member of the Ordnance Select Committee and a member of the Committee on Explosives. He was thus in closest touch with the burning questions that presented themselves for solution on the introduction of rifled guns. At this time (1860) the Government might possibly have secured his services for a further considerable period if they had promptly offered him a position suited to his growing reputation as a gunner of original ideas and untiring energy; but the Government acted too late, and a good offer found that he had already bound himself by contract to enter the Elswick firm as the director of its ordnance department. He, however, was retained on several Government committees, upon which his presence was invaluable, as he had the means at Elswick of carrying out many special researches, the results of which he freely placed at the disposal of the Government.

Noble's first important work in exterior ballistics appears to have been his experiments with the electro-ballistic apparatus of Navez, which had the object of making a close determination of initial velocity. He ascertained the causes which affect the velocity both with smooth-bore and rifled guns, and in particular he showed that with reduced powder charges the air-space in the powder chamber had a notable effect. He also discussed at length the law of dependence of the resistance of the air upon velocity in connection with previous researches of Probert, St. Robert, Mayevski, and Didion. The next paper, "On the Ratio between the Forces tending to produce Translation and Rotation in the Bores of Rifled Guns," was of much importance at the time it was written. Rifled guns were getting bigger every day, and there was much difference of opinion as to the best method of rifling and, in particular, as to the relative merits of uniform and increasing twist. He showed that with the uniform twist the force required to give rotation was only a small fraction of that required to give translation, and that in all cases the increment of gaseous pressure due to rifling was insignificant. With regard to the increasing twist (parabolic system of rifling) he also made a thorough mathematical investigation, and found again that the pressure on the studs due to rifling is only about 2¼ per cent. of the pressure required to give translation; also that the substitution of parabolic for uniform rifling reduces by about one-half the maximum pressure on the studs; and that the increment of gaseous pressure due to rifling, tending to burst the gun, is exceedingly small and less than that which obtains when the rifling is uniform.

His researches in interior ballistics properly so called commenced when he first went to Elswick, but the first publication appears to have been in the Proc. Roy. Inst. for 1871, "On the Tension of Fired Gunpowder." Previous investigators, de la Hire, Robins, Count Rumford, Cavalli, Neumann, Mayevski, Rodman, had obtained results for the pressure exerted by gunpowder fired in a closed vessel varying from 1000 to 100,000 atmospheres. Bunsen and Schischkoff later found 4374 atmospheres, about 29 tons on the square inch, for the pressure which the gases may approximate to but can never reach. Commencing in the year 1861, Noble, in conjunction with Sir W. Armstrong, carried out a large number of experiments, employing a chronoscope specially invented by himself. This beautiful instrument was able to measure a millionth of a second of time with ease. It was used in conjunction with a series of crusher gauges in determining the pressures exerted by the powder gases at various places along the bore extending from the powder chamber to the muzzle. The results were of first-rate importance. It was shown that the maximum pressure of fired ordinary gunpowder of unit density is not much above 40 tons to the square inch, but that in large guns, owing to the violent oscillations produced by the ignition of a large mass of powder, the pressure is liable to be locally exalted to an extent which endangers the endurance of the gun while detracting from the useful effect. It was also found that the intensity of this wave action is directly influenced by the position of the vent or firing point, and that it is desirable to have as short a powder cartridge as possible.

Noble's remaining researches in gunnery, extending over nearly fifty years, may be for the most part summed up under the title "Researches on Explosives." In these he was for many years associated with Sir Frederick Abel and Sir James Dewar. The objects in view were to ascertain the products of combustion of powders fired in circumstances similar to those which exist in guns—to ascertain the pressure exerted by the products of combustion at the moment of explosion and the law of its variation with the gravimetric density; to find the influence of the size of grain; to find the effect upon the products of a change in the pressure under which firing takes place; to measure the volume of the permanent gases liberated; to compare the explosion in a closed chamber with that in the powder chamber of a gun; to find the heat generated; and, finally, the work which the explosive is capable of performing on a projectile in the bore of a gun. That this lengthy programme was successfully carried out was largely due to Noble's extraordinary ability and energy. The results obtained were of the utmost importance to the manufacture of guns of all calibres. When fired in a closed space the temperature of the explosion of gunpowder was found to be 2200° C. The total work of gunpowder when indefinitely expanded was found to be 332,000 grm.-metres per gramme of powder, or 486 foot-tons per lb. of powder.

It is impossible in this short notice to say more upon these results, which are fully set forth in communications printed in the Transactions of the Royal Society between the years 1875 and 1879. The experiments were repeated as gunpowder gradually altered in physical characters,

and ultimately, when the cordite explosives were under consideration, a new set of experiments pointed out the modifications in gun construction that were necessary. It may safely be said that Noble threw light upon every question of internal ballistics. No doubt at Elswick he had very great facilities, but these would have been of no avail if he had not supplied practical knowledge and scientific insight, and supported these by his vigorous mind and untiring energy. It has been said that when a problem has been correctly stated, much has been already done towards its solution. When internal ballistics was in a state of chaos, Noble was able to extract the real questions from much that was irrelevant, and to give them a scientific statement. The result of his work has been that the splendid guns which we possess in the Navy and Army are at least as good as any in the world. It is certain that no history of gunnery will be complete which does not devote much space to a description of his pioneer work. That work was recognised on two occasions by the Royal Society: in 1870, when he was elected to the Fellowship, and in 1880, when he was awarded a Royal Medal.

P. A. M.

DR. R. ASSHETON, F.R.S.

BRITISH zoology, which recently sustained a severe loss by the death of Prof. Minchin, has received a second blow by the unexpected death of Dr. R. Assheton, which occurred at his residence, Riverside, Grantchester, near Cambridge, on October 24.

Dr. Assheton was born at Downham Hall in Lancashire in 1863, and belonged to an old Lancashire family. He was educated at Eton and afterwards entered Trinity College, Cambridge, where he came under the influence of the new school of embryology founded by Foster and Balfour and ably carried on by Sedgwick. He read for the Natural Sciences Tripos, in which he took first-class honours when he graduated in 1886. Thereafter he devoted himself to research in embryology, and was not long in making a name for himself. In 1889 he was appointed lecturer in zoology under Prof. Milnes Marshall in Victoria University, Manchester, and he held this post until Prof. Marshall's death in 1893. In 1901 he was appointed lecturer in biology to the medical school in Guy's Hospital, and took up his residence in Grantchester; he resigned this office in 1914 in order to give his whole time to teaching and research in Cambridge, where he was appointed lecturer in animal embryology. In the same year he received the well-merited honour of election into the Royal Society.

Assheton's earlier work was concerned with the difficult subject of mammalian embryology, and especially with the earlier stages of development and the beginnings of the placenta. He undertook a costly series of investigations into the early development of the sheep, and arrived at a novel view of the origin of the wall of the blastoderm vesicle from which the fœtal part of the placenta is principally derived. This he considered to be endodermic, not, as had always previously been believed, ectodermic. We think that this view is not adequately supported by the evidence which he adduced, and that it will scarcely survive. But Assheton did not by any means confine himself to mammalian embryology. The early stages of development of the frog, and the development of the curious Egyptian fish, *Gymnarchus niloticus*, also became the subjects of his researches.

From the very beginning of his work there was one feature by which Assheton was distinguished from most of his contemporaries. He was not content either with the simple description of developmental processes or with the search for their phylogenetic significance. In every case he endeavoured to analyse these processes into the differential rates of growth which underlay them, and then to find reasons for the differential rates of growth in differences of nutrition. He was, in a word, the first experimental embryologist in England. He succeeded in opening the hen's egg and keeping it still alive and developing for some days, and in this way he was able to watch the development of one and the same embryo, and by suitable tests to measure its growth. At a time when many embryologists were inclined to accept the view of His, that the nervous and skeletal axes of vertebrates were built up by the gradual concrescence of two lips bordering an elongated slit, Assheton was able to show that this view was an entire misinterpretation of the events, and to propound a solution which substituted for the alleged concrescence a growth in length of the embryo which he called *deuterogenesis*. All subsequent careful work has supported Assheton's view. Finally, in a paper entitled "The Geometrical Relation of the Nuclei in an Invaginating Gastrula (Amphioxus), considered in connection with cell-rhythm and Driesch's conception of entelechy," he measured swords with the "entelechy" of Driesch, and in substituting for that mystical factor a simple force which may well be of chemical or physical nature. At the time of his death Dr. Assheton was engaged in the preparation of a text-book of the embryology of mammalia. If this work was at all near completion it is to be hoped that it may be published, as otherwise a most valuable compilation of facts and a storehouse of illuminating ideas would be lost to science.

Dr. Assheton married a daughter of Sir Thomas Bazley, Bart., and is survived by his widow, one son, and two daughters. His son is serving as an officer in the 1st Cambridgeshire Regiment. He had a most charming personality which attracted all who knew him, and his loss will be deeply regretted by a wide circle of colleagues and friends.

E. W. M.

NOTES.

WE notice with deep regret the announcement of the death, on November 1, at sixty-seven years of age, of Sir Arthur Rücker, F.R.S., principal of the University of London from 1901 to 1908, and previously professor of physics at the Royal College of Science, South Kensington.

THE death is announced, on October 30, in his eighty-fourth year, of Lord Welby, president of the Royal Statistical Society, and for many years permanent secretary to the Treasury.

THE ninetieth illustrated Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Prof. H. H. Turner, his title being "Wireless Messages from the Stars."

THE director of the Meteorological Office reports that information has been received from the Seismological Observatory at Eskdalemuir, Scotland, of the record of a large earthquake which occurred at 7 a.m. on November 1, in or near Japan.

WE learn from the *Times* that the Nobel Prize for Medicine for 1914, of the value of about 8000*l*., has been awarded to Dr. Robert Bárany, professor of otology in the University of Vienna, for his work on the physiology and pathology of the vestibule of the ear. The prize for medicine for 1915 is reserved until next year.

PROF. KAMERLINGH ONNES announces in the *Nieuwe Rotterdamsche Courant* that he has received news from Vienna of the death of Prof. F. Hasenöhrl, professor of physics in the University of Vienna, who was killed in action on the Italian front. The deceased, who was a pupil of Boltzmann, began in 1899 an investigation on the dielectric constants of liquefied gases, in the cryogenic laboratory at Leyden. Having returned to Vienna, he became privat-dozent, and later succeeded Boltzmann, whose collected papers he edited with much care. Earlier in the war in Galicia, Prof. Hasenöhrl had been wounded in the shoulder, but after a complete recovery he again went to the front, where his lamented death occurred.

THE Naval Consultation Board appointed by national scientific and engineering societies at the request of the secretary of the U.S. Navy, has approved a plan for the establishment of a research and experimental laboratory for the Navy. It is recommended that the laboratory should be situated on tide water of sufficient depth to permit a "Dreadnought" to come to the dock. It should also be of complete equipment, to enable working models to be made and tested to destruction. The Board suggests that the investment for grounds, buildings, and equipment should total approximately 1,000,000*l*.; and the annual working expenses should be between 500,000*l*. and 600,000*l*.

A NOTE in *Engineering* for October 29 gives some particulars of the new monitors. Without accepting as technically accurate the somewhat picturesque details published in official accounts, it may be assumed that the Admiralty designers have succeeded in producing vessels with the heaviest of guns which are practically immune from torpedo attack. Some mount 14-in. guns in a central turret, others have one 9·2 in. bow and one 6-in. stern guns, and others, again, two 6-in. guns. The 14-in. guns fire projectiles of ¾ ton weight, and the range is 15 miles. Our 6-in. gun "throws 100 lb. of high explosive 12 miles without overreaching itself." The vessels are not of great speed—this is not required. Only six months elapsed from the time that the demand for their design was made until they fired their first shot. It is a great credit to all concerned, notably to the workmen in the shipyards, that this need was so promptly met.

THE *Morning Post* of November 2 publishes the following message from its Paris correspondent referring to the close relations now possible between science and the French Army:—By becoming Minister of Public Instruction and Inventions Affecting National Defence in the new French Cabinet, M. Painlevé will, it is hoped, be able to place the inventive skill of the nation more directly at the disposal of the Ministry of War. He has served for a considerable period as President of the Inventions Committee, and during his tenure of that office it became evident to him that every effort ought to be made to organise scientific skill and to co-ordinate effort. In his new capacity he becomes the sole intermediary between the world of science and the Army. Under the system now established one of the ways in which the Ministry will be useful to the country is that it enables the Army whenever the need arises to appeal directly to men of science for the solution of any scientific problem.

THE name of Dr. Philippe Hatt, whose death, at the age of seventy-five, we regret to announce, will be more familiar to the astronomers of the last generation than to those of the present. In the middle of the last century, when Government expeditions for scientific purposes were frequent, M. Hatt rendered good service. He organised and took part in the French Expedition to Wha Tonne, in the Malay Peninsula, where the eclipse of 1868 was successfully observed by Rayet, Tisserand, and others. 1874 found him on the bleak, inhospitable rock known as Campbell Island, to observe the transit of Venus. With André he went to the Rocky Mountains for the observation of the solar eclipse of 1878, and four years later he had a prominent place in the French Expedition to Chubut to observe the second transit of Venus. Less sensational, but equally meritorious, work M. Hatt achieved in the course of his professional career as a hydrographic engineer. So far back as 1866 he was entrusted with the task of making a new survey of the coast of Cambodia, and the lower course of the River Saigon. At the time of the French annexation of the country he explored the Gulf of Siam, and demonstrated the value of Gahn-Ray Bay as the site of a commercial port. Later he devoted himself to hydrographic work on the French coast, to the triangulation of Corsica, and the observation of tidal phenomena, concerning which he produced some valuable memoirs. He was elected in 1897 a member of the French Academy of Sciences, in the section of geography and navigation, in succession to M. Antoine d'Abbadie.

IT is claimed that a Swedish engineer, M. Wulff Normelli, has invented an ammonium nitrate explosive, Normellite, which has a bursting effect 25 per cent. better than that of any other explosive. It is claimed also to be safer than most explosives, being very insensitive to shock. This latter is characteristic of ammonium nitrate explosives, which require a powerful detonator, and frequently a priming of the loose explosive. Since Favier took out his patents in 1884–85 for an ammonium nitrate powder containing naphthalene, paraffin, and resin, very many explosives of this class have been introduced. The hygroscopic nature of the salt necessitates enclosing the explosive in some waterproof envelope. On account of the low temperature on firing and the production of little or no flame-producing gases, this class of explosives is particularly favoured for use in fiery coal mines. With the nitrate all kinds of combustible materials are employed, such as di- and tri-nitrotoluene, dinitronaphthalene, charcoal, etc. Other nitrates are frequently substituted for a portion of the ammonium nitrate. Roth in 1900 took out patents for the use of aluminium powder in such explosives, the idea being to utilise the high temperature attained by the oxidation of this metal, and thus greatly increase the power. Ammonal is such a mixture, containing, in addition to the nitrate and aluminium, trinitrotoluene and charcoal. It has been claimed that ammonal is a very powerful explosive, and is more effective than a similar weight of cast picric acid (lyddite) in breaking up a shell. It is therefore not improbable that Normellite is an explosive of similar type to ammonal.

THE council of the Chemical Society has sent to every fellow a letter directing attention to the Government scheme for the organisation and development of scientific and industrial research. In accordance with this scheme, a Committee of the Privy Council has been appointed, and also an Advisory Council of scientific men whose primary functions are to advise the Committee of Council on—(i) proposals for instituting specific researches; (ii) proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; (iii) the establishment and award of research studentships and fellowships. The council of the Chemical Society considers it to be the urgent duty of every fellow to render all assistance possible to the Advisory Council by suggesting suitable subjects for research. As pointed out in the White Paper, the results of all researches financed by public funds will be made available under proper conditions for the public advantage, and the council feels assured that every fellow will place patriotic duty before private gain at such a time. Suggestions for purely scientific researches will be appreciated, but those having a direct bearing on chemical industry and its promotion will naturally receive a preference. Suggestions should be sent to the council of the Chemical Society, Burlington House, W.; those suggestions which are considered suitable to receive the financial aid indicated by the scheme will be forwarded to the Advisory Council.

THE committee which was constituted last year to promote testimonials to Profs. Perry and Harrison on their retirement from the staff of the Imperial College (Royal College of Science) has now completed its labours. We are informed that in each case there was a gratifying response to the appeal to former students and colleagues for subscriptions, and that the committee has thereby been enabled to carry out its purposes completely. The testimonial to Prof. Harrison, who had been associated with the department of mathematics and mechanics during thirty-two years, has taken the form of an illuminated address, accompanied by valuable personal gifts. In the case of Prof. Perry, former students of the Finsbury Technical College desired to be associated with the testimonial, in recognition of his valuable services to that institution prior to his joining the staff of the Royal College of Science in 1896. The governing body of the Imperial College having readily consented to act as trustees, the aim of the committee was to establish a permanent memorial of Prof. Perry's work in the form of a medal or prize to be awarded annually at each of the two institutions. In view of Prof. Perry's desire that the testimonial should not include a personal gift, the whole of the subscriptions became available for the founding and endowment of medals. Dies have been prepared from designs by Mr. Charles Wheeler, of the Royal College of Art, and these, together with a stock of medals, and a certificate for 4½ per cent. War Loan Stock, have recently been placed in the custody of the Imperial College. A silver medal will be awarded annually to a student of the Imperial College for distinction in mathematics and mechanics, and at the Finsbury College a similar award will be made for distinction in mathematics and engineering. The governing body has expressed its high appreciation of the committee's decision in associating the Perry medal, and the administration of the fund, with the Imperial College, and has stated that the gift is regarded as a fitting testimony to the inspiring personality of one who took such a prominent part, both in the Royal College of Science and in the Imperial College, in the teaching of mathematics and mechanics. Prof. Perry has also expressed his gratitude for the honour which has been conferred upon him by the subscribers, and by the Imperial College. The obverse of the medal is a striking portrait, and a plaster copy of the original large model has been presented to Prof. Perry.

THE report of the Government Museum at Madras for 1914–15 is a record of steady progress. The prehistoric collections of Mr. R. Bruce Foote have been rearranged, and the Hindu, Buddhist, and Jain sculptures, which include an important collection from the Amaravati Stupa, have been classified. Considerable stores of Roman coins which are being discovered year by year, including those of the Emperors Nero, Trajan, and the Empress Faustina, illustrate the important trade intercourse between Rome and southern India in the early period after the Christian era.

THE Museum Journal of the University of Philadelphia for March, 1915, but only recently received, is

almost entirely devoted to an account of the expedition under Dr. Farabee, which has now been nearly two years in the field. His first journey had for its object the exploration of the boundaries of Venezuela and Brazil. He then visited the Macusi tribe in southern British Guiana, a most perilous undertaking. He next started for the upper waters of the Amazon and conducted archæological investigations on the island of Marajo, near the mouth of the river. From there he again proceeded to the Upper Amazon. Large ethnological collections have been made, but these cannot be fully examined until the expedition returns to the United States. Meanwhile this preliminary report, illustrated by a fine collection of photographs, is of much interest.

HIS HONOUR JUDGE J. S. UDAL contributes to the September issue of *Folk-lore* an interesting account of the practices connected with what is known as the Obeah cult in the West Indies. These include the worship of the criboe, a large black, non-venomous serpent, and some ghastly rites of human sacrifice. It has been asserted by some writers that these practices have now ceased, but Mr. Udal has collected a large mass of evidence from law proceedings and other authoritative sources to prove that this is not the case. He ends by expressing the hope that "now that the consciences of the public of our West Indian colonies and of the Home Government have begun to realise to what terrible lengths any indulgence towards or weakening in the repressive enactments against this widespread plague of Obeah may lead, that we shall see the rapid disappearance of any objectionable features in its cult, leaving only, it may be, a harmless residuum that may still afford some interest to the student and lover of folk-lore."

THE *Psychological Review* (vol. xxii., No. 4) contains an interesting summary of an "Experimental Investigation of the Subconscious," by Miss L. J. Martin. In view of the great interest now being shown in the treatment of mental diseases by psychological means, any method which enables the physician to penetrate below the threshold of consciousness is at least worthy of consideration. The Freudian technique of psycho-analysis requires a long training, and even so, is open to various objections. Hypnotic methods are not always possible or suitable. Miss Martin claims that the "image" method has certain definite advantages over the methods usually adopted for tapping the subconscious.

AN article on "Variability in Performance during Brief Periods of Work," which appears in the *Psychological Review* (vol. xxii., No. 5), has some bearing on a problem of great moment at the present time. Investigations into the conditions of, and remedies for, industrial fatigue are now occupying the attention of a committee of the British Association, and any contribution to the processes involved in work of any nature may be significant. This paper shows that an individual varies in the success of his performance of given tasks even though these last but one minute. The authors, as a result of their experiments, think it probable that mental fatigue is not as rare as is sometimes supposed, but that the repair process is so rapid, compared with muscle repair, that, as work is usually done, the loss may be compensated for during brief intervals of relaxation.

THOSE responsible for the care of museums will welcome the "General Guide to the Collections in the Manchester Museum," which has just been published by Messrs. Longmans, Green and Co. at the modest price of 3*d*. It is a model of what such guides should be, and is admirably illustrated. Perhaps its most interesting section is that on Egyptology, which contains a tabular statement of the various periods of Egyptian history from the pre-dynastic to the Roman, with the dates of each according to Petrie and Breasted.

DR. J. M. DEWAR, in the *Zoologist* for October, continues his notes on "The Relation of the Oystercatcher to its Natural Environment," discussing, in this section, the summer environment. Though, during most of the year, a dweller by the seashore, this species shows a marked preference for an inland breeding-place. The area chosen by Dr. Dewar for his observation station is typical of its kind, and his notes should be carefully read in comparison with the accounts which have been given of the reproductive period of individuals which, perhaps for lack of suitable inland stations, establish their nurseries by the seashore. This number also contains same interesting notes by Mr. G. T. Rope on the vagaries of choice displayed by cats in the matter of diet, citing numerous instances where earthworms, fungi, raw potatoes, baked pears, tomatoes, cucumbers, and marrow-seeds were preferred to a meat diet.

A VALUABLE summary on the "Status, Plumages, and Habits of the Wren of St. Kilda," by Mr. W. Eagle Clarke, appears in the *Scottish Naturalist* for October. The St. Kilda wren is one of the most interesting of the five-and-twenty endemic species now recognised by the British Ornithologists' Union, and though made known more than thirty years ago, this is the best account yet given of its habits, plumages, and relation to environment. In the same issue Mr. William Taylor records the "History of the Triassic Reptile *Scleromochlus taylori*." Dr. A. Smith Woodward, it may be remembered, some years ago expressed the opinion that this very fragmentary fossil should be regarded as a diminutive bipedal dinosaur, with a jerboa-like mode of locomotion. Baron von Huene now comes to the conclusion that it was not a crawling, walking, or jumping animal, but that its short, spreading hands and long feet show it to be well suited for climbing trees, and that it may have possessed some kind of flying membrane, recalling the bat in this respect. On the whole, we incline to think Dr. Smith Woodward's view is much the more probable.

IN Bulletin No. 20 of the Department of Agriculture, Ceylon, on "The Effect of Different Intervals between Successive Tappings of *Hevea brasiliensis*." the interesting conclusion is reached that after five years' continuous tapping there is no evidence that the yield obtained in a given time by tapping at an interval of five or seven days will ultimately exceed that obtained by more frequent tapping.

THE recently issued part (part i., vol. vi.) of the Annals of the Royal Botanic Gardens, Peradeniya, is almost entirely occupied by a series of papers by Mr. T. Petch, the Government botanist. Of these the most important contribution is that on "Horse-hair Blights," belonging to the genus Marasmius. *M. equicrinis* is the common species of the eastern tropics, while *M. sarmentosus* is the species found in the West Indies. Mr. Petch devotes his attention to the Ceylon species, which are described in some detail and illustrated by an excellent series of plates. The mycelium of these fungi is thin and rhizomorphic, and spreads freely over bushes and trees at some height above the ground; the pileus is borne on a slender petiole, and bears only a small number of gills.

A COLLECTION of fungi from Australia and New Zealand made by Mr. W. N. Cheeseman during the visit of the British Association to Australia and New Zealand last year is described by Miss E. M. Wakefield in Kew Bulletin No. 8. Twenty-eight of the 100 species enumerated are endemic to Australia, and these include the seven new species described. Five of the new species show close affinity with European or North American types. Forty-eight species were found to be common to Europe or North America, sixteen to the tropics of Africa and the East, and six cosmopolitan in the tropics generally. Only two species occur in the tropics of South America as well as in Australia. Attention was paid especially to the Polyporaceæ and Thelephoraceæ, and the collection consists mainly of specimens belonging to these groups. The principal features of the new species are illustrated in the plates.

Symons's Meteorological Magazine for October gives some very interesting details on the rains for September, which varied considerably in different parts of the British Isles. The rainfall table shows an excess of rain in parts of Scotland and in the south-east of England, whilst elsewhere there was a deficiency. At Gordon Castle the excess for the month amounts to 3·17 in., the fall being 222 per cent. of the average, whilst at Seathwaite the deficiency for the month was 9·20 in., the fall being only 18 per cent. of the average. A special article is given on the floods in the north-east of Scotland which occurred in the closing week of September, when the floods are stated not to have been equalled in many districts since the famous Moray floods of August, 1829. The area of maximum rainfall was located on the shores of Moray Firth, near Inverness, the fall for the twenty-four hours on September 25 being 4·07 in. at Fortrose, 3·78 in. at Nairn, and 3·64 in. at Inverness. The total fall for the three rain days September 24, 25, and 26 amounted to 5·47 in. at Nairn, the rain really falling in about forty hours. The river at Nairn overflowed its banks and occasioned much damage, whilst sixteen bridges and culverts were carried away. The Daily Weather Charts issued by the Meteorological Office show very distinctly the advance and movement of the cyclonic disturbance which occasioned the rainfall, the central area being situated over the south of Scotland on the morning of September 25. The rainfall in the south-east of England on September 29, which caused an excess for the month, was due to the passage of a cyclonic disturbance along the English Channel, and centred over the Straits of Dover on September 29.

AN interesting account of attempts to improve the somewhat primitive methods used in certain of the native industries of India is found in a paper by Mr. A. Chatterton, in Bulletin No. 55 of the Agricultural Research Institute, Pusa. It deals with the manufacture of jaggery in South India, and gives an account of experiments made to introduce power-driven sugar-cane mills as a substitute for the bullock-driven mills hitherto universally used. A description is also given of improvements in methods of evaporation introduced with the object of increasing the yields obtained from the juice; with the existing wasteful methods these are far lower than they should be.

THE October number of the Journal of the Röntgen Society contains the interim report of the committee on the standardisation of X-rays when administered for medical purposes. It mentions most of the methods of determining the quality or hardness and the intensity of the X-rays falling on a surface, with the intention of providing a proper basis for a more extended discussion of the relative merits of the various methods at a later date. On the whole the report seems in favour of the half-value method of determining quality. The rays are sent through a stepped wedge of a standard material—generally bakelite—and fall on a fluorescent screen. Beside the wedge is placed a metal plate with holes through it which remove half its material, and the step of the wedge which gives, on the screen, the same intensity of image as the metal plate is noted. For determinations of intensity the report apparently approves some form of ionisation method, as most of the other methods give undue weight to the softer rays.

AN important paper on the theory of grinding was read at the Institution of Mechanical Engineers on October 15 by Mr. J. J. Guest, of Birmingham. Apart from side issues, the speed limit of the grinding wheel is controlled by the strength of the material of the wheel, and for reasons of production the wheel is to be used at the highest safe surface-velocity. The author considers that the component of the work-velocity which is normal to the wheel surface (termed the "normal material velocity") is the fundamental controlling factor. This velocity is given by

$$v_1 = v\sqrt{2t\frac{d+D}{dD}},$$

where v is the surface velocity of the work, t is the reduction in diameter being effected, and D and d are the diameters of the wheel and work respectively. This quantity, as has been said, is the controlling factor, and if it is too large the wheel will wear unduly, while if it is too small the wheel will glaze. Again, the work done in grinding off metal is proportional to the volume removed, *i.e.* the rate of grinding, $\frac{1}{2}vtc$, depends on the power used, c being the traverse. vtc cannot exceed a certain amount, b, and for production reasons should be kept up to that amount, hence $vt=b/c$, together with the above

equation, will serve to determine the values of v and t for any particular case, and are sufficient for the purpose. The author gives several numerical applications of this theory, which appears to be of general application in the selection of speeds in plain and internal work.

THE *Engineering Magazine* for October contains an article on the forests of the United States, by Mr. Leonard Lundgren. Before the coming of the white man these forests covered an area of about 800 million acres, and contained about 5200 billion board feet of lumber. Fire has destroyed as much timber as has been utilised for industrial purposes, and as much again has been wasted through poor logging and milling operations, and through clearing land for agricultural purposes. The forests at present cover an area of 550 million acres, and contain about 2900 billion board feet of lumber. Seventy-six per cent. of this is owned privately, 21 per cent. is held by the United States in the national forests, and 3 per cent. is on other public lands. The annual cut is approximately 43 billion board feet; at this rate, if there were no new growth and the present demand were maintained, the timber supply would last about sixty-five years. It is reasonable to expect that all agricultural lands, cultivated or uncultivated, will ultimately be placed under crops that will give the greatest economic return. Some of the lands now under cultivation will unquestionably revert to forest. Through reducing the per capita consumption (at present amounting to 260 cubic feet of wood per inhabitant), protection against fire, and increasing the natural growth per acre by the practice of forestry, it is probable that a balance between production and consumption will eventually be reached by the force of natural economic laws. In Saxony, where forestry has been practised for many years, the annual production is 93 cubic feet per acre. Forestry is practised in the United States on Government and State lands only, and the estimated annual production is 12 cubic feet per acre.

MESSRS. CONSTABLE AND CO., LTD., 10 Orange Street, London, W.C., inform us that they now publish in this country, at 6*s.* 6*d.* net, Prof. L. T. More's "The Limitations of Science," reviewed in the issue of NATURE of September 2 last (vol. xcvi., p. 3).

OUR ASTRONOMICAL COLUMN.

THE ANDROMEDA NEBULA.—According to a notice in the September Journal of the Royal Astronomical Society of Canada, a determination made at Mount Wilson of the radial velocity of this nebula indicates a recessional motion of 329 km./sec. from measures of nine lines. The spectrogram was obtained on five consecutive nights during last November (thirty-four hours' exposure), by means of a small slit spectrograph at the primary focus of the 60-in. reflector. There is stated to be no evidence of either bright lines or rotational displacement.

A LONG-PERIOD SPECTROSCOPIC BINARY.—Mr. J. B. Cannon has made a determination of the orbital elements of μ Persei, a spectroscopic binary having the somewhat long period of 284 days. The spectrum is of the solar type, and a number of lines being available for measures, a good determination of velocity could be made. Forty-eight plates secured during 1913–15 were measured, and combined to give 0·11 normal places, the velocity-curve coming out very nearly symmetrical. A range of velocity of 41 km. is indicated, whilst 39 km. was found from seven Lick spectra.

SUN-SPOTS AND TEMPERATURES.—In continuation of the statistical investigation of the question of seasonal variations of weather Dr. Gilbert T. Walker publishes (Memoirs of the Indian Meteorological Department, vol. xxi., part xi., p. 61) a paper giving the correlation coefficients of sun-spots with temperature for a large number of stations generally distributed over the earth's surface. A paradoxical defect of temperature associated with times of maximum sun-spots is revealed for a large number of stations, more especially tropical. An area of positive coefficients, however, stretches from the Arctic over the western parts of Europe.

THE UNION OBSERVATORY.—Circulars Nos. 26 and 27 have recently come to hand. The first of these gives details in continuation of the investigation by blink-microscope of the variable stars in the region of η Argus. A table is given showing the results of special search for known variables not picked up in the first survey. The variability of a star (R.A. 10h. 9m. 36*s.*, declination $-58°\ 24{\cdot}3'$ (1875), announced last year by Dr. A. W. Roberts, is confirmed.

In the other circular Mr. J. Voûte gives the results of measures of sixty-seven double stars, employing the Bosler-Salet inverting prism to eliminate systematic errors in the measurement of position angles. The instrument used was the 9-in. Grubb refractor. It was specially desired to obtain experience of the working of the method under additional instrumental conditions in extension of measures made at Leyden and at the Cape. In this process the position-angle is determined as the mean of measures made before and after inverting the field by means of a prism. The present results are in good agreement with the Leyden series, amply supporting the favourable opinions regarding the method.

A message from the observatory, dated October 7, informs us that a 12th magnitude star, with a proper motion of $5{\cdot}1''$ a year, has been found with the blink apparatus. Full particulars will be given in a forthcoming Union Observatory Circular. The place of the star is (1900) R.A. 14h. 22·9m., declination $-62°\ 2'$.

THE ORBIT OF B.A.C. 5890.—A noteworthy spectroscopic investigation of this binary system has been made by Mr. F. H. Parker at the Dominion Observatory, Ottawa (*Jour. Roy. Astr. Soc.*, Canada, September). The reductions are based entirely on pairs of measures made on plates showing spectra of both components. Nineteen such plates were secured at Ottawa, but the dispersion only sufficed to separate the lines near primary maximum. However, one of three Lick spectra showing double lines was taken near apastron, thus fortunately bridging the gap. The measures of the Canadian plates were grouped into five normal places, those from the Lick plates giving three additional points. The photographic magnitude of the star is 4·9, the spectrum being of the F type, and the lines are described as "broad." The masses of the components are very nearly equal (25 : 24). The period is 26·27 days, whilst the eccentricity has the rather large value 0·49. This is not altogether exceptional, for, curiously enough, binaries having periods 12–30 days yield an average value of 0·462, according to the data recently collected by Dr. Sven Wicksell.

IRON AND ALLOTROPY.

MANY points of theoretical interest as well as of practical importance were brought forward in the discussion "On the Transformation of Pure Iron" opened by Dr. A. E. Oxley, of the University of Sheffield, at the Faraday Society on October 19. The subjoined summary describes the main views presented.

It is now believed by many metallurgists that the A_3 transformation of iron can be explained without assuming allotropic change, but the A_2 transformation is regarded as involving allotropy. The crystalline state is one of extreme molecular association (physical polymerism or the grouping of chemical molecules under the influence of mutual physical forces), and if allotropy is determined solely by the nature and extent of this association each substance will show an unlimited number of allotropic forms within a finite temperature interval. On this view the attempts to show that A_3 involves allotropic change while A_2 does not, need not have been made.

To surmount the difficulty presented by the existence of so many allotropes, two different types of allotropy have been recognised: (1) the two-phase (discontinuous) type, (2) the one-phase (continuous) type. Having adopted these, we have now to determine experimentally to which type a given transformation belongs. The burden is thus thrown on our experimental refinements, and the difficulty of drawing a sharp distinction is at once apparent—the distinction can only be arbitrary. In this connection the liquid crystalline state is interesting. There are some substances which show no liquid crystalline state on fusion, but do so prior to recrystallisation. Thus we have two-phase allotropy on heating and one-phase allotropy on cooling.

Defining allotropy as a difference of atomic structure of the chemical molecule (consistent with the transformation from oxygen to ozone, or from one isomer to another), a distinction can be drawn between allotropy and crystalline grouping. Allotropic modifications will form characteristic space lattices determined by their molecular constitutions. It does not necessarily follow that a difference of crystalline symmetry implies allotropy, for *identical* molecules can be packed together in different ways (Barlow and Pope, Trans. Chem. Soc., vol. lxxxix., p. 1741, 1906). We must distinguish between the forces holding the molecules in a definite space lattice and those holding the atoms in the molecule.

Now on the theory of the molecular field Weiss has shown (*Comptes rendus*, vol. cxliv., p. 25, 1907) that the so-called β and γ forms of iron have the same Curie constant, and A_3 is not an allotropic change point. In a later research (*Journ. de Phys.*, vol. l., p. 965, 1911, and *Arch. des Sciences*, 1913), using more recent data, *and assuming that each atom possesses an integral number of magnetons*, Weiss shows that the transition β to γ may be represented by a change from a tri-atomic to a di-atomic molecule. If, however, the magnetic particle of the γ state consists of three molecules, and that of the β state of two molecules, the magneton theory will still hold, but now the number of atoms in a molecule of each state is the same. This latter view seems more probable, for γ iron possesses more magnetons per molecule than β iron does, and therefore unless we suppose that the molecules of the β state are so bound together that one cannot rotate without dragging along its neighbours, it seems difficult to account for the rapid increase of susceptibility on cooling through A_3.

If cooling through A_3 is accompanied by a closer grouping of the molecules in the direction (characteristic for each crystal) of spontaneous magnetisation, there will be no change of crystalline symmetry, while the increased interaction of the molecules will give rise to ferro-magnetism. The change of molecular distances in the perpendicular directions is not important from a magnetic point of view, each molecule being mainly constrained by the one in front and the one behind in the direction of the magnetic axis. (Silver iodide (hexagonal) is an example of a crystal which expands along the axis while contracting in perpendicular directions.) Thus this interpretation is not necessarily inconsistent with known magneto-striction data or with determinations of thermal expansion (linear or volume) of a *mass* of iron crystals.

The thermal evolution at A_3 is due to the readjustment of molecular distances. The rise of temperature observed is 14° C. (Arnold, B.A. Report, Sheffield, 1910), and taking 0·1 as the specific heat of iron, the thermal evolution is 1·4 cals./gram. This value is small compared with the latent heat of fusion of elements, *e.g.* P (5), Bi (13), Cd (14), Pb (5), Ag (22), Sn (14), Zn (28), Ga (19). Further these latent heats are in general small compared with the thermal evolutions in known allotropic and isomeric transformations. Thus

Allotropic { 96 gr. ozone = 96 gr. oxygen + 59,200 gr. cals.
31 gr. yellow phosphorus = 31 gr. red phosphorus + 21,000 gr. cals.

Isomeric { 78 gr. dipropargyl = 78 gr. benzene + 100,000 gr. cals.
58 gr. allyl alcohol = 58 gr. acetone + 18,600 gr. cals. = 58 gr. propaldehyde + 22,600 gr. cals.[1]

The transition $2O_3 \longrightarrow 3O_2$ has the thermal value +600 cals./grm. The transition $\beta \longrightarrow \gamma$ in iron has the thermal value −1·4 cals./grm. Can we regard this latter transition as $2Fe_3 \longrightarrow 3Fe_2$?

The small thermal evolution at A_2 favours the view expressed above that the transformation involves a molecular regrouping, similar to that occurring in the ordinary process of crystallisation, rather than a rebuilding of the atomic structure of the molecule. Hitherto we have not considered a change within the atom itself, such as a variation of the electric or magnetic elements. Some such change must occur in the iron atom, as it enters into different chemical combinations, otherwise how can we explain why iron carbonyl, $Fe(CO)_5$, is diamagnetic, while ferrous chloride, $Fe(Cl)_2$, is strongly paramagnetic? Do we not here have a kind of atomic allotropy? In this sense the allotropic theory may be consistent with the carbide theory which attributes the properties of carbon-steels to definite compounds of iron with carbon (such as cementite (Fe_3C)). Magnetic phenomena appear to be so definitely related to the atom that the existence of different types of iron atom is suggested inevitably, and the suggestion would not be at variance with modern views of atomic structure. Many arrangements of electronic orbits in dense atoms are theoretically possible.

The work of Prof. W. H. and Mr. W. L. Bragg must be considered in relation to any phenomenon of crystals. They have shown the difficulty, even in ordinary cases, of even defining the molecules of the crystals, although in many cases this is possible. But to determine by their method whether, in an iron crystal, any atom has a *special* relation to one of those surrounding it, would be nearly impossible. The optical effects which they investigate are determined only by the nucleus or core of the atom, and the outer arrangements in the atom, determining its allotropic forms, might differ considerably without being capable of detection except perhaps by their magnetic properties. On these lines, therefore, no immediate objection to the existence of such different types of atom

[1] *Vide* Muir and Wilson, "Elements of Thermal Chemistry," pp. 250–52, for many other examples.

can apparently be raised, and the suggestion of atomic allotropy appears worthy of development as a possible interpretation of others among the phenomena of pure iron, which considerations of space have excluded from the present summary.

During the discussion several interesting slides showing variations of the micro-structure of iron were exhibited by Prof. H. C. H. Carpenter.

PREVENTIVE MEDICINE IN PENNSYLVANIA.[1]

PREVENTIVE medicine is a science so likely to appeal to the genius of the American people that it is of considerable interest to read the reports issued in July, August, and September of 1914, by the Pennsylvania State Department of Health on various aspects of its activities.

As elsewhere, so in the State of Pennsylvania, the force which caused the development of preventive medicine was the compulsion exerted by outbreaks of disease. An epidemic of typhoid fever in 1885 was the means of obtaining the enactment of a previously twice defeated Bill to establish a State Board of Health, which, however, at first was much circumscribed in its powers and duties. A severe outbreak of smallpox in the years 1901–04 impelled the Legislature to establish a State Department of Public Health.

At its head is a Commissioner of Health, with very great powers of initiative, on whom falls the duty of appointing whatever assistants he may find necessary to carry on the work. The State Department of Health has direct executive control over all public health problems of every sort in the more rural portions of the State, comprising four-fifths of the land area and one-quarter of the total population. Over the remainder of the population, aggregated in the more densely populated townships, which are required to maintain their own local boards of health, the State Department of Health has advisory and supervisory control, but no executive responsibility except in relation to sanitary engineering, tuberculosis, and the collection of vital statistics.

The State administrative machinery, therefore, in some respects resembles, but in others is in marked contrast to, that of an English county health department. Both have general supervisory and advisory duties with regard to the smaller areas within their compass. The English county department has, however, nothing approaching to the wide general executive functions of the Pennsylvania State Department, although in some respects—for example, in the control of tuberculosis—their activities are akin. The complete responsibility of the Pennsylvania State Department for the health of the public in the rural portions of its area has no analogy in county administration in this country. The English system is based far more than is the Pennsylvanian on local as opposed to central administration.

The organisation of the State Health Department would appear to be on very effective lines. Out of the central department have crystallised a number of sub-departments, or divisions, dealing respectively with vital statistics, school medical inspection, sanitary engineering, tuberculosis dispensaries and nursing, sanatoria, housing, laboratories, and the distribution of biological products. The chief of each division reports directly to the health commissioner. There are two special divisions, one of which conducts all the auditing and accounting and part of the purchasing for other divisions, while the other attends to the whole of the storage and shipment of materials. The divisional executive officers are thus left free to devote their energies to the more essential public health work.

Comparison of the work of some of these divisions with that of health departments in this country is instructive. For example, the registration of births and deaths is far more closely bound up with public health in Pennsylvania than is the case in England and Wales, in which it is not in any way directly controlled by the Health Department; whereas in Pennsylvania, on the contrary, the Division for Vital Statistics, a branch of the State Health Department, under the direct supervision of a health officer, is responsible for precisely the same work as is done by our local and central registrars in respect of births and deaths and marriages.

In the same way the school medical service, instead of being, as is unfortunately the case in this country, a separate service affiliated only for reasons of convenience to the public health service, is recognised in Pennsylvania as essentially a branch of public health, and as such is administered by the State Health Department through a division of medical inspection. Sanitary engineering, again, carried out as it is by a special division of the State Health Department, is much more clearly recognised as a function of public health than is the case in this country.

Perhaps the most striking feature of the Pennsylvanian scheme is its systematic educational campaign. All reports sent in from every division of the Health Department to the Health Commissioner are dealt with from their public health aspect, and are then handed over to an educational section of the central department, where they are rewritten and issued in popular form as lectures, circulars, leaflets, newspaper talks, or periodical bulletins. This eagerness to popularise technical knowledge is an important side of public health work, which could with advantage be better developed in this country. In general administration, probably English methods give as good results, though possibly in more circuitous ways. Pennsylvania has had the advantage of beginning at a time when it could develop its public health system at one stroke and as a whole, and so could largely avoid the errors and vagaries of a system which has grown by accretion. H. P. N.

[1] Pennsylvania Health Bulletin, July, August, September, 1914.

CHEMISTRY AT THE BRITISH ASSOCIATION.

ALTHOUGH so many topical subjects were, on account of the war, excluded from the discussions of the section, the attendance at the meetings was on the whole satisfactory, exceeding the anticipations of the earlier part of the year. It is, however, clear that anything like general interest can only be evoked in the Chemical Section by discussions on rather broad subjects, papers giving the results of researches on some particular branch being only too frequently delivered to nearly empty benches. This not infrequently arises from the paper being so specialised that the author is practically the only person in the room capable of appreciating its significance and value. One cannot help feeling that the atmosphere of the Chemical Society or other specialised body would be more sympathetic. Under the exceptional circumstances of this year foreign guests were few in number, but the section had the pleasure of welcoming and listening to two of our Belgian allies—Prof. Henry and Prof. Ranwez, from Louvain, the former giving an account of researches on the preparation and properties of vinylacetic nitrile, which he has carried out in Prof. Perkin's laboratory at Oxford during his residence in this country, while the latter contributed a paper to the discussion on smoke.

The section met on three mornings and two afternoons, so that although the whole meeting was shorter than has hitherto been customary, chemists actually devoted more time to the consideration of their subject, and the usually rather risky experiment of afternoon sessions proved entirely successful, chiefly no doubt because social counter-attractions were absent.

Two mornings were occupied by discussions, one dealing with smoke and its prevention, the other with homogeneous catalysis. Manchester, to the residents in the rural parts of these islands, shares with Sheffield an unfortunate reputation for griminess; therefore the discussion on smoke was peculiarly apposite. Though many efforts are made to combat the smoke evil, not only because of its noxious effects, but also because of the enormous waste due to the huge quantities of valuable fuel constantly being poured into our atmosphere, much still remains to be done towards the economic utilisation of our fuel supply. The discussion was opened by Mr. E. D. Simon, chairman of the Manchester Air Pollution Advisory Board, with a paper on "Lines of Research in Smoke Abatement." Briefly, it may be said that it is only by a systematic investigation of the amount of deposit, its nature, and the diminution of light caused by the smoke cloud at different observing stations near our great cities, that the damage done can be evaluated and the origin of the smoke determined.

Though factories and works contribute greatly to the nuisance, the domestic chimney, so dear to the Briton, appears to be the offender most capable of correction, by the use of gas fires, coke fires, and semi-coked coal. Mr. Simon put forward the plea that the British Association should appoint a committee to co-ordinate the work of local municipal committees who are prosecuting research on the most efficient forms of domestic heating and the economical and smokeless use of fuel in general.

The position, so far as Manchester is concerned, was further explained by Mr. Haldane Gee and Prof. Knecht, the former reviewing the work carried out in Manchester during recent years, and the latter giving an account of Manchester smoke from the chemical point of view.

Prof. Wynne gave a number of statistics for the city of Sheffield based on an investigation of the rain-water collected in various soot gauges, from which it appears that if the district where the armament works are situated be excepted, the results for the other portions of the city show a remarkable approach to uniformity independent of the direction of the prevailing wind. If the contribution of house fires to the air pollution can be based on the proportion of tar and ammonia collected in the rain-water, no material difference could be traced between the winter and summer six months.

The effect of smoke on vegetation was considered by Prof. Ranwez and Mr. Ruston, the first describing the more general effects on trees and plants, while the second paid special attention to the reduction of sunlight, action of acids on leaves, soot formation, enzyme, and bacterial action. Smoke pollution is apparently an inhibitor of the enzymic chemical changes which occur in plants, and consequently near cities our plants are less bright, form less reserves, and produce seeds with diminished germinating capacity and energy, all which is but too apparent to the gardener in our urban districts. The electrical precipitation of smoke also came in for comment, and some slides shown by Mr. Vernon Harcourt incidentally illustrated well the possibility of combining economic fuel combustion on a domestic hearth with the artistic merits of the English fireplace, a point too infrequently considered, but most of the other speakers were concerned with the necessity for taking some action, compulsion if necessary, to force the inhabitants of this country to be more economical in fuel.

The outcome of the whole discussion, which in many ways was supplementary to that at the Birmingham meeting, was that a committee to consider the whole question of the economic use of fuel and smoke prevention was appointed by the Chemical Section.

The discussion on homogeneous catalysis was opened by Prof. Lewis, who advanced a new theory based fundamentally on Planck's quantum hypothesis. The physical idea underlying the theory is that ordinary or "thermal" reactions are due to the infra-red radiation which is necessarily present throughout any material system in virtue of its temperature. When a reaction proceeds without the addition of a catalyst, it is to be inferred that the density of the radiation "naturally" present in the system is sufficient to activate the molecules taking part in the reaction. Each type of molecule has its own characteristic absorption and emission bands in the infra-red, and can only be activated chemically by the absorption of radiant energy the frequency of which corresponds to one or more of these band positions. The function of a positive catalyst is to increase the radiation density of the frequency which corresponds to that of the reacting substance, a negative catalyst reduces the energy frequency of the "useful" frequency, and so hinders the rate of decomposition of the substance. By applying Planck's quantum theory to the simple case of a mono-molecular reaction Prof. Lewis deduced the following expression for the variation of the velocity constant (k) with the temperature (T):—

$$\frac{d \log k}{dT} = \frac{N h\nu}{RT^2}$$

where N is the number of molecules in one gram-molecule, h is Planck's constant, R the gas constant per gram-molecule, and ν the characteristic infra-red vibration frequency of the reacting substance. By the aid of this expression values for ν can be calculated from temperature coefficient measurements. From measurements on the inversion of cane-sugar and hydrolysis of methyl acetate it was calculated that ν corresponded to a wave-length 1·2 μ and 1·9 μ values in fair agreement with the absorptions determined by Coblentz from transmission spectra. Prof. Lewis suggested that as aqueous hydrochloric acid possesses a band in the same region, its known positive catalytic effect is due to this cause, as also the catalytic effects due to pure and mixed solvents.

By considering that only those molecules react which reach a "critical" condition, namely, one in which they acquire a certain energy in excess of the average energy per molecule in the system, a view put forward by Marcelin in a series of papers on reaction velocity, Mr. J. Rice deduced a very similar expression for the relation of k to T to that given by Prof. Lewis. Considerable forces must hold the molecules together when near each other, but the law of force must be such that at a "critical" distance the attraction must weaken and change to repulsion, thus implying that the potential energy between two molecules is greatest at the critical distance apart. By assuming that the forces involved are electromagnetic and subject to modification due to the changes in radiation density produced by the catalyst, results are obtained in agreement with the existing experimental data.

Prof. F. Francis exhibited and described an apparatus for measuring the velocity of catalysis of nitrosotriacetonamine and allied derivatives by hydroxyl ions, based on the determination of the pressure of the nitrogen evolved. The method was also of use to determine the concentration of the hydroxyl ions. He also described the curious effect of neutral salts, and pointed out that nearly the same quantitative retarda-

tion of the velocity is produced in some cases by chlorides and hydroxyl ions. Small concentrations of sulphates produced an acceleration. Prof. Francis pointed out that the order in which the salts effected the velocity constant was that found in the lyotropic series, iodides producing the greatest and chlorides the least effect.

Dr. N. V. Sidgwick pointed out that while Prof. Lewis assumed the catalytic activity to be proportionate to the amount of catalyst, this was not always true, and further that temperature coefficients of isomeric changes and mono-molecular changes in general are abnormally high. The immediate need before proceeding to theory is an accumulation of more exact experimental data.

Prof. E. C. C. Baly from spectroscopic observations considered that as the first step in a chemical change must be the conversion of the reacting substance into an intermediate very reactive state, a positive catalyst must be an agent which converts more substance into this state. This intermediate state results from the introduction of a definite amount of energy. He suggested that probably the actual amount of energy thus needed was constant and independent of the value of the vibration frequency, and that the numbers of energy quanta necessary to produce the critical increment at any given vibration frequency of the molecule are numerically related to one another. Further, the relation between the active and inactive forms does not obey the law of mass action.

It may be fairly concluded from the discussion that far more experimental data must be accumulated, particularly as regards temperature coefficients and changes of velocity with increasing amount of catalyst.

Other parts of the mornings were occupied with several short papers, of which space will only permit the titles. Dr. H. F. Coward and Prof. A. Harden described and exhibited some lecture diagrams used by Dalton in illustration of his atomic theory; Dr. A. Hynd, "Configuration in the Sugar Group"; Dr. H. J. S. Sand, "A New Cadmium Vapour Arc Lamp"; Dr. Robert Mond, "Ruthenium Di-Carbonyl"; Dr. W. E. S. Turner, "Ionisation in Solvents of Low Dielectric Constant," and, jointly with Mr. J. D. Cauwood, "The Molecular State of Salts in Solution."

On one afternoon Prof. W. J. Pope gave an experimental lecture on liquid crystals, and on the other Prof. W. A. Bone, Prof. H. B. Dixon, and Dr. H. F. Coward contributed papers on combustion and explosion of gases with some experimental illustrations.

The account of the work of the section would not be complete without a word about the discussion on isotopes, which took place in Section A, but which was peculiarly interesting to chemists. The discussion is summarised in the report of the proceedings of Section A in NATURE, but results obtained by Dr. Whytlaw Gray from microchemical experiments showed that certain salts, iodides, chlorides, chromates, etc., of the product of decay of radium emanation are identical as far as solubility, crystalline form, etc., with the corresponding salts of lead. Approximate determinations of their melting points also indicated identity. To the chemist this is perhaps more convincing than a volume of deductions by a physicist.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

THE president of the section, Major Lyons, was unable to be present, owing to pressure of work in connection with the war, and his address, the main part of which was printed in NATURE of September 23, was read by Mr. H. Yule Oldham. His other duties were undertaken by the vice-presidents, Mr. G. G. Chisholm, Prof. J. W. Gregory, Mr. Harry Nuttall, and Mr. H. Yule Oldham.

On Wednesday morning Mr. A. R. Hinks gave an account of the map which is being compiled at the Royal Geographical Society under the direction of the General Staff on the scale of 1 : 1,000,000. After a brief statement regarding the inception and progress of the map, and the principles upon which it is being compiled, he referred in more detail to various methods of showing relief, the selection of names, the index to boundaries, and marginal names. Mr. B. C. Wallis followed with a paper on methods of representing the distribution of population upon maps, and more especially upon the maps already described by Mr. Hinks. Taking the Buda-Pest sheet, he showed how the population in each administrative area might be assumed to be evenly distributed throughout, and how the density when located in the centre of the area might be treated in the same way as a spot height in contouring. He also showed maps, and discussed methods for the representation of the various ethnic elements in the population.

Wednesday afternoon was devoted to a series of short papers by members of the section who had been present at the Australian meeting. Mr. O. J. R. Howarth compared several well-known maps showing the distribution of vegetation in Australia, and pointed out the great discrepancies which existed between them. He suggested that a committee might at some suitable time be appointed to examine and criticise the material upon which distributional maps in general are based, and that such a committee might begin its labours by a consideration of the material available for the construction of vegetation maps of Australia.

Prof. J. W. Gregory discussed the relations of the central lakes of Westralia, which he believes to be basins left by the dismemberment of a Miocene river system. He considers that the drainage from lakes Giles, Barlee, and Ballard originally passed through Lake Raeside south-eastward to the sea, and that the channel from Lake Ballard south-west through Lake Deborah to the Swan River, indicated on a recent contour map of Western Australia, was of later date and was formed by the blocking of the south-eastern outlet by wind-borne drifts.

Mr. J. McFarlane described the Burrinjuck Dam and the Murrumbidgee irrigation area in New South Wales, with special reference to the interaction between man and his environment in an irrigation area.

Mr. H. Yule Oldham explained the various stages in the explorations by which the outline of the Australian continent had been filled up.

Thursday morning was devoted to joint discussions with Sections C and H respectively. The discussion with Section C on the classification of land forms was opened by Dr. J. D. Falconer, who proposed to set up two classes of land forms, each containing two orders :—

Class A, endogenetic forms: Order I., negative forms; Order II., positive forms. Class B, exogenetic forms: Order I., degradation forms; Order II., aggradation forms.

The two orders of endogenetic forms are then subdivided into four families :—

Family 1. Forms due to superficial volcanic activity.
2. Forms due to sub-crustal volcanic activity.
3. Forms due to radial movements.
4. Forms due to tangential movements.

Similarly, the two orders of exogenetic forms are each subdivided into nine families :—

Family 1. Forms due to the action of the run-off
2. Forms due to the action of percolating water.

3. Forms due to the action of streams and rivers.
4. Forms due to the action of life.
5. Forms due to the action of lightning.
6. Forms due to the action of sun-heat.
7. Forms due to the action of the atmosphere.
8. Forms due to the action of frozen water.
9. Forms due to the action of the sea.

Each family is then subdivided into genera and species or specific forms.

In the discussion which followed, Prof. Gregory said that the initial difficulty lay in the fact that different classifications were required by geography and by geology. Dr. Falconer had restricted the term land-form to what may be called the simple land forms, whereas the term was originally used for the greater features which may be called compound land forms. The geographer needs a classification which is based more on form than on origin, and uses familiar terms, such as mountain and valley, with the help of which he cannot afford to dispense. At the same time, Prof. Gregory thought that Dr. Falconer's classification would be of great value as a complete systematic tabulation of land-forming processes. Prof. Grenville Cole said that a systematic classification of land forms might tend to check the descriptive faculty of the teacher. Brief but comprehensive description in language familiar to the reader or hearer was needed to bring home the relation of surface features to man's life among them. Close definition, especially in the Greek language, might tend to obscure the beauty of a landscape. Mr. G. G. Chisholm considered that the distinctive feature of geography was the study of the influences of terrestrial local conditions and place relations. For this, of course, description was necessary, but he failed to see the utility for geographical description of the subdivisions of simple land forms proposed by Dr. Falconer.

The discussion with Section H on Racial Distribution in the Balkans was opened by Prof. G. Elliot-Smith. An account of it will appear under the proceedings of Section H.

In the afternoon a paper was read by Mr. P. M. Roxby on North China and Korea, in which he embodied many of the observations he had made in these regions during his tenure of an A.K. fellowship. He dealt principally with the railway situation, the relations of China to Russia and Japan, China's interest in the European war, and the work of the Japanese in Korea. The paper was illustrated by an exceptionally fine set of lantern-slides. Dr. R. N. Rudmose Brown followed with an account of the political and economic position of Spitsbergen at the outbreak of war. He also explained the results obtained by Dr. W. S. Bruce's expedition there in 1914.

On Friday, the first business before the section was the consideration of the report of the committee appointed to inquire into the choice and style of atlas, textual and wall maps for school and university use. Thereafter a paper was read by Mr. Raymond Curtis on the distribution of population in the district round Leek, in which he showed how in the agricultural area the village nucleus of farmhouses might develop in turn into the inn-village, the shop-village, the fair-village, and the market-town. Mr. C. B. Fawcett discussed the development of the middle Tees and its tributaries. He considered that the river system as a whole is in a comparatively early stage of development, but that it is the product of at least three distinct cycles of erosion. The morning sitting concluded with a paper by Prof. H. J. Fleure on the distribution and movement of population in South Britain in early times. In Neolithic times the chief areas occupied in England were the chalk downs, the moorlands of the south-west, the Cotswold top, a few patches, especially near Birmingham, in the Midlands, some valleys in the East Anglian Chalk, as well as a few chalk ridges, *e.g.* above the Fen edge, the Pennines, moorland tops in South Wales, etc. Descendants of the dark, long-headed Neolithic folk who occupied these uplands are still found in the valleys around them, except that they have been nearly washed out along the Chalk in the south, which has been the scene of many invasions. The valleyward movement of people in Britain is therefore of great importance, and evidence was given of its various stages and sociological results.

The proceedings of the section concluded on Friday afternoon, when Prof. Patrick Geddes read a paper on the study of cities, and at its conclusion conducted a party over an exhibition arranged by himself and Miss Barker of maps, pictures, books, and broadsheets illustrating the war, and of regional surveys illustrating the geographical and historical growth of cities.

JOHN MCFARLANE.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—A memorial service for members of the University who have fallen in the war was held at the Temple Church on November 1. The service was conducted by the Master of the Temple, assisted by Bishop Hine and the Bishop of London. The Bishop of Kingston was the preacher. Included in the list of the 250 graduates and students commemorated are the forty-two from University College, thirty from King's College, eighteen from the Royal College of Science and the Royal School of Mines, sixteen from the City and Guilds College, seventeen from the South Eastern Agricultural College, seventeen from St. Bartholomew's Hospital, fourteen from Guy's Hospital, nineteen from London Hospital, and eleven from St. Mary's Hospital.

It is understood that the appointment of a Principal to succeed Sir Henry Miers is to be postponed.

The first list of students serving in the war, to whom honorary war degrees have been granted, has been published.

OXFORD.—The Vice-Chancellor's choice of a Romanes lecturer has this year fallen on an Oxford resident, viz., Prof. E. B. Poulton, Hope professor of zoology. The subject chosen, "Science and the Great War," is one to which Prof. Poulton is known to have given great attention. For many years past he has lost no opportunity of advocating an increased attention to the results of scientific research in relation to all forms of national activity, whether warlike or peaceful, and he has consistently deplored the indifference to the lessons of science displayed by most of our leading politicians and statesmen. A valuable and interesting utterance on his part is confidently looked for. The lecture will be delivered at the University Museum, on Tuesday, December 7, at 3.30 p.m.

IT is stated in the *Pioneer Mail* of October 9 that on October 1 the Bill to establish and incorporate a teaching and residential Hindu university at Benares was passed into law. Now that the Bill has been passed, the promoters are about to address themselves to details connected with the institution. The Viceroy will lay the foundation-stone early in February. It is hoped that the work of the University will be entered upon by July next, though, of course, at first on a limited scale.

THE calendar for the present session of the University of Sheffield provides an excellent example of the numerous directions in which a modern university succeeds in meeting the needs of the area in which it is situated. The industries of the Sheffield district are reflected in the degrees in applied science which the University is prepared to confer. Students may take courses in preparation for the degrees of bachelor, master, or doctor in engineering science, or in metallurgy. In both these subjects, too, considerable specialisation is encouraged. The examinations of the University admit to associate membership of various professional institutions, and are also recognised by certain Departments of State. The University grants a diploma in domestic science. A two years' course of work in the University and the Sheffield Training College of Domestic Science has been arranged. The scientific portion of the course will be taken at the University, and the technical work in cookery, laundry, and housewifery at the training college. The calendar also provides full information of a well-planned University extension scheme which has been developed, and of numerous flourishing university societies. At the same time the more usual University work is carried on in the faculties of arts, pure science, medicine, and law, concerning which detailed particulars are given.

THE abridged calendar for the current session of University College, University of London, has been received. Detailed guidance is given as to the courses which should be taken by students proposing to graduate in one of the faculties of the University. The calendar points out that facilities for post-graduate work and research are provided in all departments of the college. There is a large science library in which the books concerned with the various scientific departments are grouped. The library contains all the most important scientific periodicals (British and foreign). The particulars of the studentships, scholarships, fellowships, and prizes for research awarded by the college run to forty-eight pages. The list of original papers and other publications from the various departments of the college since the provost's report in last year's calendar fills fourteen pages, and is good evidence that the reputation of the college as a centre for research is being worthily maintained. In his report, printed in the calendar, on the work of the last session at the college, the provost said the benefactions of the year had inevitably been fewer than usual, but he was able to announce that upwards of 1100*l.* had been added to the fund for the new chemical laboratories. He said a further sum of between 800*l.* and 900*l.* was needed for the partial minimum equipment for this session. The equipment necessary for the new physico-chemical laboratory is of a special and expensive character, and will cost about 10,000*l.*

THE calendar for the present session of the University College of North Wales has been received. Students of the college prepare for degrees of the University of Wales, which have been so framed as to allow great freedom in the choice of subjects of study. Each degree in arts or science may be regarded as a certificate of the preliminary knowledge required at matriculation, and of subsequent study pursued at one of the constituent university colleges for a period of three years, and tested at each stage by university examinations. Advanced study is encouraged not only by the existence of advanced and honours courses, but also by the regulations for the higher degrees, and by the award of university fellowships and studentships for research. As an instance of the encouragement given to research we notice the calendar states the professor of mathematics is glad to furnish subjects for research in applied mathematics to candidates who have acquired a substantial knowledge of the subject-matter of the honours course and to direct their work. A number of aeroplane problems are generally available. In the agricultural department of the college, students may prepare for degrees in agriculture and rural economy or for the college diploma in agriculture, and their practical work is assisted by the facilities provided at the college farm of 675 acres. With the aid of a grant from the Development Fund, well-equipped laboratories have been provided, and full facilities are now available for the investigation of problems submitted to the department.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 26.—M. Ed. Perrier in the chair.—G. **Bigourdan**: Astronomical observations made in France before the foundation of the Academy of Sciences. An outline of the life of Fabri de Peiresc (1580–1637).—H. Le **Chatelier** and B. **Bogitch**: The preparation of alkaline nitrates starting with calcium nitrate. The preparation of ammonium nitrate by the interaction of calcium nitrate and ammonium sulphate presents difficulties on the large scale owing to the pasty mass being nearly impossible to filter. After heating under pressure in a closed vessel to 150° C., the calcium sulphate forms larger crystals, and the ammonium nitrate can be readily removed by washing.—Fréd. **Wallerant**: Some crystallographic peculiarities of aniline nitrate. This salt is dimorphous, with a well-marked transition point at 97·6° C.—Henryk **Arctowski**: Variations in the ratios between faculæ and sun-spots.—Luc **Picart**: A criterion for the identification of the minor planets.—Ernest **Esclangon**: The quasi-periodic integrals of a linear differential equation.—A. **Angelesco**: Associated polynomials with several variables.—St. **Procopiu**: Electromotive force due to motion. A study of the electromotive forces set up in a symmetrical cell (metal-electrolyte-metal) by motion of one electrode or of the electrolyte.—A. **Guilliermond**: Some cytological observations on the mode of formation of anthocyanic pigments in flowers.—G. **Riviere** and G. **Bailhache**: *Amygdalopersica formonti.* An account of some peculiarities in the growth of an almond grafted on to a peach tree.—Th. **Guilloz** and E. **Stock**: A compass for the location of metallic fragments in the body.—E. **Vasticar**: The structure of the auditory cell.—F. **d'Hérelle**: The biological method for the destruction of locusts. Details of an improved method for utilising the *Coccobacillus acridiorum* for the destruction of locusts.—E. **Aubel** and H. **Colin**: The reaction of the medium and filtration of toxins.

BOOKS RECEIVED.

The R.P.A. Annual for 1916. Pp. 80. (London: Watts and Co.) 6*d.* net.

Illustrations of Positivism. By Dr. J. H. Bridges. New edition, enlarged and classified by H. G. Jones. Pp. xiii+480. (London: Watts and Co.) 3*s.* 6*d.* net.

The Dramas and Dramatic Dances of Non-European Races in special reference to the Origin of Greek Tragedy. By Prof. W. Ridgeway. Pp. xv+448. (Cambridge: At the University Press.) 15*s.* net.

Field Analysis of Minerals. By G. D. McGrigor. Pp. 86. (London: *The Mining Magazine.*) 3*s.* 6*d.* net.

Food Economy in War Time. By Profs. T. B. Wood and F. G. Hopkins. Pp. 35. (Cambridge: At the University Press.) 6*d*. net.

Forty-fourth Annual Report of the Local Government Board, 1914–15: Supplement in Continuation of the Report of the Medical Officer of the Board for 1914–15, containing a Report on Maternal Mortality in connection with Child-bearing and its relation to Infant Mortality. Pp. 140. (London: H.M.S.O.; Wyman and Sons, Ltd.) 7½*d*.

Modern Chemistry and its Wonders. By Dr. G. Martin. Pp. xvi+351. (London: Sampson Low and Co., Ltd.) 7*s*. 6*d*. net.

The Student's Handbook to the University and Colleges of Cambridge. Fourteenth edition, revised to June 30, 1915. Pp. 14+701. (Cambridge: At the University Press.) 3*s*. net.

The Caliph's Last Heritage: a Short History of the Turkish Empire. By Lt.-Col. Sir M. Sykes. Pp. xii+638. (London: Macmillan and Co., Ltd.) 20*s*. net.

Statistical Theory of Energy and Matter. By Dr. T. Wereide. Pp. xv+170. (Kristiania: Gyldendalske Boghandel Nordisk Forlag.)

Tasmania. Department of Mines. Geological Survey Bulletin, No. 20: The Catamaran and Strathblane Coal Fields and Coal and Limestone at Ida Bay (Southern Tasmania). By W. H. Twelvetrees. Pp. 59; Maps and Sections. (Hobart: J. Vail.)

Canada. Department of Mines. Mines Branch: Results of the Investigation of Six Lignite Samples obtained from the Province of Alberta. By B. F. Haanel and J. Blizard. Pp. viii+110. Report on the Salt Deposits of Canada and the Salt Industry. By L. H. Cole. Pp. vii+152. (Ottawa: Government Printing Bureau.)

British Birds. Written and illustrated by A. Thorburn. In four volumes. Vol. II. Pp. vi+72+plates 21–40. (London: Longmans and Co.) Set of 4 vols., 6 guineas net.

An Introduction to Social Psychology. By W. McDougall. Ninth edition. Pp. xvii+431. (London: Methuen and Co., Ltd.) 5*s*. net.

Mechanical Technology: being a Treatise on the Materials and Preparatory Processes of the Mechanical Industries. By Prof. G. F. Channock. Pp. x+635. (London: Constable and Co., Ltd.) 7*s*. 6*d*. net.

Unit Photography. By F. M. Steadman. Pp. xi+160. (London: Constable and Co., Ltd.) 8*s*. 6*d*. net.

Limes and Cements: Their Nature, Manufacture, and Use. By E. A. Doncaster. Pp. xii+212. (London: Crosby Lockwood and Son.) 5*s*. net.

The Molecular Volumes of Liquid Chemical Compounds from the Point of View of Kopp. By G. Le Bas. Pp. xii+275. (London: Longmans and Co.) 7*s*. 6*d*. net.

The Life Story of an Otter. By J. C. Tregarthen. New edition. Pp. xiii+188. (London: J. Murray.) 2*s*. 6*d*. net.

The Story of a Hare. By J. C. Tregarthen. New edition. Pp. xi+196. (London: J. Murray.) 2*s*. 6*d*. net.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—A Diagram to Facilitate the Study of External Ballistics: Prof. W. E. Dalby.—An Application of the Principle of Dynamical Similitude to Molecular Physics: W. B. Hardy.—The Motion of a Stream of Finite Depth past a Body: R. Jones.—Deep-sea Water Waves caused by a Local Disturbance on or beneath the Surface: K. Terazawa.—The Consumption of Carbon in the Electric Arc: W. G. Duffield.

SOCIETY OF ENGINEERS, at 7.30.

TUESDAY, NOVEMBER 9.

MINERALOGICAL SOCIETY (Anniversary Meeting), at 5.30.—Crystallographic Relations of Allied Substances traced by means of the Law of Valency Volume: W. Barlow.—Torbernite: A. F. Hallimond.—The Solution of the Problem of Four Tautozonal Poles: T. V. Barker.—Crystals of Iron Phosphide from a Blast-Furnace: L. J. Spencer.—The Meteoric Stone of Cronstad, Orange River Colony: Dr. G. T. Prior.

ZOOLOGICAL SOCIETY, at 5.30.—Some Notes upon the Anatomy of *Rana tigrina*: Dr. G. E. Nicholls.—(1) The Distribution of Secondary Sexual Characters amongst Birds, with Relation to their Liability to the Attack of Enemies; (2) Some Observations on Pattern-blending, with Reference to Obliterative Shading and Concealment of Outline: J. C. Mottram.—A Collection of Mammals from the Coast and Islands of S.E. Siam, with an Account of the Fruit-bats by Dr. Knud Andersen: C. Boden Kloss.—Fauna of West Australia. III. A New Nemertean—*Geonemertes dendyi*, sp. n.—being the First Recorded Land Nemertean from Western Australia. IV. *Palæmonetes australis*, sp. n., being the First Record of the Genus in Australia: Prof. W. J. Dakin.

THURSDAY, NOVEMBER 11.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Effects of Function Activity in Striated Muscle and the Submaxillary Gland: J. Barcroft and T. Kato.—Studies on *a priori* Pathometry. I.: Sir Ronald Ross.—The Spread of the Excitatory Process in the Vertebrate Heart. I. The Toad's Ventricle. II. The Tortoise Ventricle. III. The Dog's Ventricle. V. The Bird's Heart. IV. The Human Ventricle: T. Lewis.—Analyses of Agricultural Yield. II. The Sowing-date Experiment with Egyptian Cotton, 1913: W. L. Balls and F. S. Holton.—Williamsoniella, a New Type of Bennettitalean Flower: H. H. Thomas.

FRIDAY, NOVEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.

CONTENTS.

	PAGE
Science and Nescience	251
The Complete Works of Tycho Brahe. By **Dr. Andrew C. D. Crommelin**	252
Plant-Breeding	253
The British Rainfall Organisation	254
New Books on Chemistry. By **J. B. C.**	255
Our Bookshelf	256
Letters to the Editor:—	
The Manganese Ore Requirements of Germany.—**Prof. H. C. H. Carpenter**	256
The Government Scheme for the Organisation and Development of Scientific and Industrial Research.—**Prof. William A. Bone, F.R.S.**	259
Science in National Affairs.—**Prof. W. M. Bayliss, F.R.S.**	260
A New X-Ray Technique.—**C. E. S. Phillips**	261
Australian Photographs.—**Prof. T. Johnson**	262
Explosive Bombs.—**Alfred S. E. Ackermann**	262
Trench "Frost-Bite." By **Prof. R. T. Hewlett**	262
British Bird Books. (*Illustrated.*) By **O. V. A.**	263
Sir Andrew Noble, Bt., K.C.B., F.R.S. By **P. A. M.**	264
Dr. R. Assheton, F.R.S. By **E. W. M.**	266
Notes	267
Our Astronomical Column:—	
The Andromeda Nebula	271
A Long-Period Spectroscopic Binary	271
Sun-Spots and Temperatures	271
The Union Observatory	271
The Orbit of B.A.C. 5890	271
Iron and Allotropy	272
Preventive Medicine in Pennsylvania. By **H. P. N.**	273
Chemistry at the British Association	273
Geography at the British Association. By **John McFarlane**	275
University and Educational Intelligence	276
Societies and Academies	277
Books Received	277
Diary of Societies	278

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